B.E. MECHANICAL ENGINEERING CURRICULUM

(2024 AND ONWARDS)

(REGULAR PROGRAMME)

Department of Mechanical Engineering
FACULTY OF ENGINEERING

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

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

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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.

OR
Passed B.Sc. Degree from a recognizedUniversity 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 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)

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. **(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. **(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 conducted 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. **(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. **(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.

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

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.

21.1 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.

21.2 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	

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

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FACULTY OF ENGINEERING

COURSE OF STUDY AND SCHEME OF EXAMINATION

(2024 Batch Onwards)

B.E. MECHANICAL ENGINEERING

SEMESTER I

Course Code	Course title	Category	Outcomes		Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
			PO	PSO	L	T	P		CIA	ESE	Total	
									40	60	100	
24BECC101	Technical English - I	HS	8,9,10,12	1,2	3	0	0	3	40	60	100	12
24BECC102	Matrices and Calculus	BS	1,2,3,12	1	3	1	0	4	40	60	100	14
24BECC103	Environmental Studies	BS	1,2,6,7,8,12	-	3	0	0	3	40	60	100	16
24BEME141	Engineering Physics (EC)	BS	1,2,3,6,9,12	1, 2	3	0	2	4	40	60	100	18
24BEME142	Python Programming	ES	1,2,3,4,9,10,12	1	3	0	2	4	40	60	100	20
24BEME111	Workshop Practices Laboratory	ES	1,2,3,4,6,7,8,9,10, 12	–	0	0	3	2	40	60	100	22
24BEMC151	Women Safety and Security*	MC	1,2,3,5,8,10,12	–	1	0	0	0	100	-	100	24
24BEMC152	தமிழர் மரபும் பண்பாடும்*	MC	–	–	1	0	0	0	100	-	100	25
				Total	**17**	**1**	**7**	**20**	**440**	**360**	**800**	

SEMESTER II

Course Code	Course title	Category	Outcomes		Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
			PO	PSO	L	T	P		CIA	ESE	Total	
									40	60	100	
24BECC201	Technical English - II	HS	8,9,10,12	1,2	3	0	0	3	40	60	100	27
24BECC202C	Transforms and its Applications	BS	1,2,3,12	1	3	1	0	4	40	60	100	29
24BEME203	Physics for Mechanical Engineers	BS	1,2,3,12	1,2	3	0	0	3	40	60	100	31
24BECC204	Engineering Graphics	BS	1,2,6,7,8,10, 12	1	3	0	0	3	40	60	100	33
24BECC205	Basics of Electrical and Electronics Engineering	ES	1,2,3,9,10,12	1	3	0	0	3	40	60	100	35
24BECC241	Engineering Chemistry	BS	1,2,3,4,9,10,1 2	1	3	0	2	4	40	60	100	37
24BECC211	Communication Skills Laboratory	ES	5,8,9,10, 12	1	0	0	2	1	40	60	100	39
24BEMC251	Yoga	ES	–	–	0	0	4	2	100	-	100	40
				Total	**17**	**2**	**8**	**23**	**380**	**420**	**800**	

*100% Internal Exam Only

SEMESTER III												
Course Code	**Course title**	**Category**	**Outcomes**		**Instruction Hours / Week**			**Credits**	**Maximum Marks**			**Pg. No.**
			PO	**PSO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**	
									40	**60**	**100**	
24BEME301B	Numerical Methods	BS	1,2,3,12	1	3	1	0	4	40	60	100	41
24BEME302	Engineering Mechanics	ES	1,2,3,10,12	1	3	1	0	4	40	60	100	43
24BEME303	Manufacturing Processes	PC	1,2,3,10,12	1	3	0	0	3	40	60	100	45
24BEME304	Engineering Thermodynamics	PC	1,2,3,4,9,10,12	1	3	1	0	4	40	60	100	47
24BEME305	Graphics, Geometric Tolerances and Drawing in Manufacturing	PC			3	0	0	3	40	60	100	49
24BEME341	Fluid Mechanics and Fluid Machines	PC	1,2,3,4,9,10,12	1,2	3	0	2	4	40	60	100	51
24BEME311	Skill Development – I Welding Process and Inspection	ES	–	–	0	0	2	1	100	–	100	53
24BEME351	Aptitude and Reasoning	MC	–	–	1	0	0	0	100	–	100	54
				Total	**19**	**3**	**4**	**23**	**440**	**360**	**800**	

SEMESTER IV												
Course Code	**Course title**	**Category**	**Outcomes**		**Instruction Hours / Week**			**Credits**	**Maximum Marks**			**Pg. No.**
			PO	**PSO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**	
									40	**60**	**100**	
24BEME401	Engineering Materials and Metallurgy	PC	1,2,9,10,12	1	3	0	0	3	40	60	100	56
24BEME402	Technology and Processes in Heavy Manufacturing	PC	1,2,3,6,7,10,12	1	3	0	0	3	40	60	100	58
24BEME441	Manufacturing Technology	PC	1,2,3,6,7,10,12	1,2	3	0	2	4	40	60	100	60
24BEME442	Thermal Engineering	PC	1,2,3,4,9,10,12	1	3	0	2	4	40	60	100	62
24BEME443	Strength of Materials	PC	1,2,3,7,8,9,10,12	1	3	0	2	4	40	60	100	64
24BEME444	Theory of Machines	PC	1,2,3,4,9,10,12	1	3	0	2	4	40	60	100	66
24BEME411	Skill Development – II NDE Methods	ES	–	–	0	0	2	1	100	–	100	68
24BEMC451	Foundation of Entrepreneurship	MC	–	–	1	0	0	0	100	–	100	69
24BEMC452	Essence of Traditional Indian Knowledge and Heritage	MC	–	–	1	0	0	0	100	–	100	70
Total					**20**	**0**	**10**	**23**	**500**	**300**	**800**	

SEMESTER V												
Course Code	**Course title**	**Category**	**Outcomes**		**Instruction Hours / Week**			**Credits**	**Maximum Marks**			**Pg. No.**
			PO	**PSO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**	
									40	**60**	**100**	
24BEME501	Design of Machine Elements	PC	1,2,3,4,8,10,12	1	3	1	0	4	40	60	100	71
24BEME541	Heat and Mass Transfer	PC	1,2,3,4,9,10,12	1	3	0	2	4	40	60	100	73
24BEME542	Metrology and Measurements	PC	1,2,3,8,9,10,12	1	3	0	2	4	40	60	100	75
24BEME5E01	Professional Elective I -Digital Technologies with CPS, IIoT and Cloud in Manufacturing	PE	1,2,3,6,7,9,10,12	1,2	3	0	0	3	40	60	100	-
24BEME5E02	Professional Elective II- Cognitive Manufacturing - AI and Machine Vision	PE	–	–	3	0	0	3	40	60	100	-
24BEME5E03	Professional Elective - III	PE	–	–	3	0	0	3	40	60	100	-
24BEME5OE01	Open Elective -I	OE	--		3	0	0	3	40	60	100	-
24BEME511	Computer Aided Modelling Lab	PC	---		0	0	4	2	40	60	100	78
24BEMC551	Community Engagement and Social Responsibility	HS	–	–	1	0	2	2	100	-	100	79
24BEMC552	Cyber Security	ES	–	–	1	0	0	0	100	-	100	80
Total					**23**	**1**	**10**	**28**	**440**	**360**	**800**	

SEMESTER VI												
Course Code	**Course title**	**Category**	**Outcomes**		**Instruction Hours / Week**			**Credits**	**Maximum Marks**			**Pg. No.**
			PO	**PSO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**	
									40	**60**	**100**	
24BEME601	Design of Transmission Systems	PC	1,2,3,6,8,10,12	1	3	1	0	4	40	60	100	82
24BEME602	Renewable Energy Sources	PC			3	0	0	3	40	60	100	84
24BEME603	Mechatronics	PC	1,2,3,6,8,10	1	3	1	0	4	40	60	100	86
24BEME641	Finite Element Method	PC	1,2,3,4,5,9,10,12	1	3	0	2	4	40	60	100	88
24BEME6E01	Professional Elective IV - Collaborative Robotics in Manufacturing with AI, ML, IIoT	PE	-	-	3	0	0	3	40	60	100	-
24BEME6E02	Professional Elective V- Additive Manufacturing	PE	-	-	3	0	0	3	40	60	100	-
24BEME6OE02	Open Elective – II	OE	-	-	3	0	0	3	40	60	100	-
24BEME691	Mini Project	PW	1,2,3,5,8,9,10,12	1	0	0	4	2	40	60	100	91
24BEME651	Universal Human Values	HS	1,2,3,4,6,7,8,9,10,11,12	1,2	1	0	0	0	100	-	100	92
Total					**22**	**2**	**6**	**26**	**420**	**480**	**900**	

SEMESTER VII												
Course Code	Course title	Category	Outcomes		Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
			PO	PSO	L	T	P		CIA	ESE	Total	
									40	60	100	
24BEME701	Principles of Management and Engineering Ethics	ES	1,2,6,8,10,12	1	3	0	0	3	40	60	100	94
24BEME702	Operations Research	PC			3	0	0	3	40	60	100	96
24BEME7E01	Professional Elective - VI	PE	-	-	3	0	0	3	40	60	100	-
24BEME791	Internship	PW	1,2,3,5,6,7,8,9,10,12	1	0	0	0	2	00	100	100	98
24BEME792	Project work Phase - I	PW	–	–	0	0	8	4	100	-	100	99
Total					**9**	**0**	**8**	**15**	**220**	**280**	**500**	

SEMESTER VIII												
Course Code	Course title	Category	Outcomes		Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
			PO	PSO	L	T	P		CIA	ESE	Total	
									40	60	100	
24BEME891	Project work Phase – II	PW	1,2,3,4,5,6,7,8,9,10,11,12	1,2	0	0	16	8	120	180	300	100
Total					**0**	**0**	**16**	**8**	**120**	**180**	**300**	

Open Electives												
Course Code	Course title	Category	Outcomes		Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
			PO	PSO	L	T	P		CIA	ESE	Total	
									40	60	100	
24BEME6OE01	Open Elective I **(Swayam – NPTEL – 12W)**	OE	–	–	0	0	0	3	40	60	100	-
24BEME6OE02	Open Elective II **(Swayam – NPTEL – 12W)**	OE	–	–	0	0	0	3	40	60	100	-
Total					**0**	**0**	**0**	**6**	**80**	**120**	**200**	

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL 1	VERTICAL 2	VERTICAL 3	VERTICAL 4	VERTICAL 5	VERTICAL 6
PRODUCT DESIGN AND DEVELOPMENT	**INDUSTRIAL AUTOMATION**	**ADVANCED MANUFACTURING TECHNOLOGIES**	**AUTOMOTIVE AND ENERGY ENGINEERING**	**DIVERSIFIED COURSES I**	**DIVERSIFIED COURSES II**
Computer Aided Modeling and Manufacturing	Smart Mobility and Intelligent Vehicles	Smart Manufacturing	Heating Ventilation Air Conditioning and Refrigeration Systems	Non Destructive Testing	Supply Chain Management
Design for Manufacture and Assembly	Introduction to Industrial Automation Systems	Green and Sustainable Manufacturing	Power Plant Engineering	Hydraulics and Pneumatics	Process Planning and Cost Estimation
Product Life Cycle Management	Embedded Systems and Programming	Advanced Machining Processes	Energy Management	Gas Dynamics and Jet Propulsion	Total Quality Management
Human Factors Engineering and Ergonomics	Industrial Robotics	Additive Manufacturing	Thermal Management of Batteries and Fuel Cells	Aircraft Systems	Entrepreneurship Development
Product Design for Manufacturing	Digital Technologies with CPS, IIOT and Cloud in Manufacturing	Computer Integrated Manufacturing	Hybrid and Electric Vehicles	Composite Materials and Mechanics	Industrial Safety
Design Thinking and Innovation	Cognitive Manufacturing – AI and Machine Vision	Flexible Manufacturing Systems	Automotive Materials, Components, Design and Testing	Computational Fluid Dynamics	Quality Control and Reliability Engineering
Design Concept in Engineering	Collaborative Robotic in Manufacturing with AI, ML, IIOT	Lean Manufacturing	---	Drone Technology	---

PROFESSIONAL ELECTIVE COURSES
VERTICAL 1: PRODUCT DESIGN AND DEVELOPMENT

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		L	T	P		CIA	ESE	Total	
						40	60	100	
24BEMExxxx	Computer Aided Modeling and Manufacturing	3	0	0	3	40	60	100	101
24BEMExxxx	Design for Manufacture and Assembly	3	0	0	3	40	60	100	103
24BEMExxxx	Product Life Cycle Management	3	0	0	3	40	60	100	105
24BEMExxxx	Human Factors Engineering and Ergonomics	3	0	0	3	40	60	100	107
24BEMExxxx	Product Design for Manufacturing	3	0	0	3	40	60	100	109
24BEMExxxx	Design Thinking and Innovation	3	0	0	3	40	60	100	111
24BEMExxxx	Design Concept in Engineering	3	0	0	3	40	60	100	113

VERTICAL 2: INDUSTRIAL AUTOMATION

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		L	T	P		CIA	ESE	Total	
						40	60	100	
24BEMExxxx	Smart Mobility and Intelligent Vehicles	3	0	0	3	40	60	100	115
24BEMExxxx	Introduction to Industrial Automation Systems	3	0	0	3	40	60	100	117
24BEMExxxx	Embedded Systems and Programming	3	0	0	3	40	60	100	119
24BEMExxxx	Industrial Robotics	3	0	0	3	40	60	100	121
24BEMExxxx	Digital Technologies with CPS, IIOT and Cloud in Manufacturing	3	0	0	3	40	60	100	123
24BEMExxxx	Cognitive Manufacturing – AI and Machine Vision	3	0	0	3	40	60	100	125
24BEMExxxx	Collaborative Robotic in Manufacturing with AI, ML, IIOT	3	0	0	3	40	60	100	128

VERTICAL 3: ADVANCED MANUFACTURING TECHNOLOGIES

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		L	T	P		CIA	ESE	Total	
						40	60	100	
24BEMExxxx	Smart Manufacturing	3	0	0	3	40	60	100	130
24BEMExxxx	Green and Sustainable Manufacturing	3	0	0	3	40	60	100	132
24BEMExxxx	Advanced Machining Processes	3	0	0	3	40	60	100	134
24BEMExxxx	Additive Manufacturing	3	0	0	3	40	60	100	136
24BEMExxxx	Computer Integrated Manufacturing	3	0	0	3	40	60	100	138
24BEMExxxx	Flexible Manufacturing Systems	3	0	0	3	40	60	100	140
24BEMExxxx	Lean Manufacturing	3	0	0	3	40	60	100	142

VERTICAL 4: AUTOMOTIVE AND ENERGY ENGINEERING

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		L	T	P		CIA	ESE	Total	
						40	60	100	
24BEMExxxx	Heating Ventilation Air Conditioning and Refrigeration Systems	3	0	0	3	40	60	100	144
24BEMExxxx	Power Plant Engineering	3	0	0	3	40	60	100	146
24BEMExxxx	Energy Management	3	0	0	3	40	60	100	148
24BEMExxxx	Thermal Management of Batteries and Fuel Cells	3	0	0	3	40	60	100	150
24BEMExxxx	Hybrid and Electric Vehicles	3	0	0	3	40	60	100	152
24BEMExxxx	Automotive Materials, Components, Design and Testing	3	0	0	3	40	60	100	154

VERTICAL 5: DIVERSIFIED COURSES I

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		L	T	P		CIA	ESE	Total	
						40	60	100	
24BEMExxxx	Non Destructive Testing	3	0	0	3	40	60	100	156
24BEMExxxx	Hydraulics and Pneumatics	3	0	0	3	40	60	100	158
24BEMExxxx	Gas Dynamics and Jet Propulsion	3	0	0	3	40	60	100	160
24BEMExxxx	Aircraft Systems	3	0	0	3	40	60	100	162
24BEMExxxx	Composite Materials and Mechanics	3	0	0	3	40	60	100	164
24BEMExxxx	Computational Fluid Dynamics	3	0	0	3	40	60	100	166
24BEMExxxx	Drone Technology	3	0	0	3	40	60	100	168

VERTICAL 6: DIVERSIFIED COURSES II

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		L	T	P		CIA	ESE	Total	
						40	60	100	
24BEMExxxx	Supply Chain Management	3	0	0	3	40	60	100	170
24BEMExxxx	Process Planning and Cost Estimation	3	0	0	3	40	60	100	172
24BEMExxxx	Total Quality Management	3	0	0	3	40	60	100	174
24BEMExxxx	Entrepreneurship Development	3	0	0	3	40	60	100	176
24BEMExxxx	Industrial Safety	3	0	0	3	40	60	100	178
24BEMExxxx	Quality Control and Reliability Engineering	3	0	0	3	40	60	100	180

Programme Educational Objectives (PEO)

- To equip students with modern tools and technology for deliberating engineering solutions and to advance scientific knowledge through basic and applied research.
- To equip students with broad knowledge through series of expert interactions to support the industry development and to address social and engineering challenges of the nation.
- To create awareness and understanding related to societal issues, apart from developing a sense of commitment to the community and profession with sincere involvement.

Programme Outcomes (PO)

- **PO1 - Engineering Knowledge:** Ability to apply knowledge of mathematics, science and engineering fundamentals for solving the complex engineering problems.
- **PO2 - Problem Analysis:** Identify, formulate, review and analyze the complex engineering problems, by conceptual and fundamental principles of mechanical engineering to reach value added sustainable conclusions.
- **PO3 - Designs / development of solution:** 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, cultural, societal and environmental consideration.
- **PO4 - Conduct investigations of complex Problems:** Ability to apply appropriate tools, technique and research knowledge to investigate complex engineering problems.
- **PO5 - Modern tool usage:** Apply modern techniques and IT tools for the design and analysis of mechanical systems.
- **PO6 - The engineer and society:** Understand the impact of engineering solutions in a societal context and to be able to respond effectively to the needs for sustainable development.
- **PO7 - Environment and sustainability:** Understanding the mechanism of pollutant formation and its control techniques.
- **PO8 - Ethics:** Understanding of human and ethical responsibilities towards the profession and society.
- **PO9 - Individual and team work:** Function effectively as an individual, and as a member or a leader in diverse teams, and in multi-disciplinary situations.
- **PO10 - Communication:** Ability to communicate effectively with engineering community and instruct in the form of reports, presentation and documents.
- **PO11 - Project management and finance:** Ability to understand the economics and cost analysis in order to take economically sound decisions.
- **PO12 - Lifelong learning:** Recognize the need for, and have the ability to engage in independent and lifelong learning.

Programme Specific Outcomes (PSO)

- **PSO1:** Acquire knowledge on fundamental and advanced background of mechanical processes and managerial skills to become employable graduate.
- **PSO2:** Develop advanced and new materials for engineering applications by use of advanced materials research laboratory.

PEO	Programme Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
1	✓	✓	✓	✓	✓							✓
2	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
3						✓	✓	✓	✓	✓	✓	✓

Total Marks: 5700

Total number of credits: 166

PEO: Programme Educational Objectives **PO: Programme Outcomes**

L: Lecture Hour **T: Tutorial Hour** **CIA: Continuous Internal Assessment: Practical Hour** **C: No. of Credits** **ESE: End Semester Examinations**

Note:

1. The passing minimum for Mandatory course is 50 marks out of 100 marks. There will be two tests of which one will be class test covering 50% of syllabus for 50 marks and other for 50 marks.
2. Credits for mandatory courses are not counted for computation of CGPA.
3. A student will be eligible to get Under Graduate degree with Honors or additional Minor Engineering, if he/she completes an additional 20 credits. These could be acquired through MOOCs.

SEMESTER – I

24BECC101 TECHNICAL ENGLISH – I 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: English at 10+2 or equivalent level

COURSE OBJECTIVES:

The goal of this course is for the students;

- To reacquaint oneself with fundamental reading and writing skills, proper grammar usage, listening, and speaking
- To improve skills in listening and speaking, in expressing oneself formally in writing, and in deducing meaning from what one reads
- To enhance 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

UNIT I **9**

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 **9**

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 question.

UNIT III **9**

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 **9**

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 **9**

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.

WEB URLs

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

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C101.1	-	-	-	-	2	-	-	2	2	3	-	2	1	-
C101.2	-	-	-	-	2	-	-	2	2	3	-	2	1	-
C101.3	-	-	-	-	2	-	-	2	2	3	-	2	1	-
C101.4	-	-	-	-	2	-	-	2	2	3	-	2	2	1
C101.5	-	-	-	-	2	-	-	2	2	2	-	2	2	1
C101	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**2**	**2.8**	**-**	**2**	**1.4**	**0.4**

SEMESTER – I

24BECC102 MATRICES AND CALCULUS 4H – 4C

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

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students;

- To provide sufficient knowledge in calculus and matrix algebra in the respective fields
- To find an extremum value for a function of several variables subject to a given constraint.
- To provide knowledge in evaluating double and triple integrals
- To 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 HOURS: 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 Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C102.1	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C102.2	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C102.3	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C102.4	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C102.5	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C102	**3.0**	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**1.0**	**-**

SEMESTER – I

24BECC103 ENVIRONMENTAL STUDIES 3H – 3C

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

End Semester Exam: 3 Hours

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 Mapping: (Low - 1; Medium - 2; High - 3)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C103.1	2	1	-	-	-	2	3	3	-	-	-	2	-	-
C103.2	2	1	-	-	-	2	3	3	-	-	-	2	-	-
C103.3	2	1	-	-	-	2	3	3	-	-	-	2	-	-
C103.4	2	1	-	-	-	2	3	3	-	-	-	2	-	-
C103.5	2	1	-	-	-	2	3	3	-	-	-	2	-	-
C103	2	1	-	-	-	2	3	3	-	-	-	2	-	-

SEMESTER – I

24BEME141	ENGINEERING PHYSICS	5H – 4C

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

End Semester Exam: 3 Hours

(i) THEORY

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 students 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 **9**

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 **9**

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 **9**

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).

UNIT IV – QUANTUM PHYSICS **9**

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 **9**

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+30

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.

REFERENCES:

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

WEBLINKS:

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

(ii) LABORATORY

LIST OF EXPERIMENTS – PHYSICS

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 Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C104.1	2	1	-	-	-	-	-	-	-	1	-	1	2	-
C104.2	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C104.3	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C104.4	2	1	-	-	-	-	-	-	-	1	-	1	2	-
C104.5	2	2	1	-	-	-	-	-	-	1	-	1	2	-
C104	**2.6**	**1.6**	**1.1**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**-**	**1.0**	**2.0**	**-**

SEMESTER – I

24BECC142 PYTHON PROGRAMMING 5H – 4C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: 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 students 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 9

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 9

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 9

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 IV FILE HANDLING, CLASS AND OBJECT 9

Introduction to files - File path - Opening and closing files - Reading and writing files - File position - Decorators - Introduction to elements of OOP - Class - Object - Inheritance - Data abstraction - Encapsulation - Polymorphism - UML class diagram - Access specifiers - Creating classes - Creating object - Accessing members - init() method - Instance, static and class methods - Importance of self - Implementing encapsulation. Illustrative programs: File operations on TEXT and CSV, Scientific calculator using class and objects.

UNIT V ERROR HANDLING, TESTING 9

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

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.

TOTAL: 30

TEXT 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.

REFERENCE BOOKS:

1. R. Nageswara Rao," Core Python Programming", 3rd Edition, Dream tech Press,2022.
2. Mark Lutz , "Learning Python" ,5th Edition , O'Reilly Publication , 2018.
3. Mark and Summerfield , "Programming in Python 3",2ndEdition ,Dorling Kindersley India Pvt. Ltd, 2019.

WEBSITES:

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

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C105.1	2	1	-	-	-	-	-	-	2	2	-	3	1	-
C105.2	3	2	1	-	-	-	-	-	2	2	-	3	1	-
C105.3	3	2	1	-	-	-	-	-	2	2	-	3	1	-
C105.4	3	3	2	1	-	-	-	-	2	2	-	3	1	-
C105.5	3	3	2	1	-	-	-	-	2	2	-	3	1	-
C105	**2.8**	**2.2**	**1.5**	**1.0**	**-**	**-**	**-**	**-**	**2.0**	**2.0**	**-**	**3.0**	**1.0**	**-**

SEMESTER – I

24BEME111 WORKSHOP PRACTICES LABORATORY 3H – 2C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Nil

COURSE OBJECTIVES:

The goal of this course is for students to

- To know the usage of appropriate tools used in foundry and sheet metal
- To provide the practical experience on basic machining operations and metal joining process
- To understand the household plumbing, electrical wiring and assembly works

COURSE OUTCOMES:

Upon completion of this course students will be able to

CO1:	prepare green sand mould using the tool and equipment	K3
CO2:	perform basic secondary manufacturing processes like sheet metal cutting, machiningand joining processes	K3
CO3:	carryout common household plumbing works	K3
CO4:	Assemble common household equipment	K3
CO5:	Carryout soldering and electrical wiring	K3

LIST OF EXPERIMENTS:

FOUNDRY:

1. Study of tools
2. Preparation of green sand mould with a solid pattern
3. Preparation of green sand mould with a split pattern

SHEET METAL:

1. Study of tools and equipment's
2. Model making – Rectangular Tray
3. Model making – Funnel

BASIC MACHINING:

1. Step Turning
2. Taper Turning
3. Drilling practice

WELDING:

1. Study of Gas welding and its equipment's
2. Study of Arc welding and its equipment's
3. Welding of Lap joint
4. Welding of Butt joint
5. Welding of T-Joint

PLUMBING:

1. Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances

ASSEMBLY:

1. Assembly of a centrifugal pump

SOLDERING AND ELECTRICAL WIRING:

1. Safety aspects of electrical wiring
2. Soldering of small electrical and electronic Circuits
3. Study of electrical materials and wiring components
4. Wiring circuit for a lamp using single and stair case switches
5. Wiring circuit for fluorescent lamps
6. Calculation of power and energy

TOTAL: 60 PERIODS

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C106.1	3	2	1	-	1	-	-	-	2	1	-	1	1	-
C106.2	3	2	1	-	1	-	-	-	2	1	-	1	1	-
C106.3	3	2	1	-	-	-	-	-	2	1	-	1	1	-
C106.4	3	2	1	-	-	-	-	-	2	1	-	1	1	-
C106.5	3	2	1	-	-	-	-	-	2	1	-	1	1	-
C106	**3.0**	**2.0**	**1.0**	**-**	**1.0**	**-**	**-**	**-**	**2.0**	**1.0**	**-**	**1.0**	**1.0**	**-**

SEMESTER – I

24BEMC151	WOMEN SAFETY AND SECURITY	H – 0C

Instruction Hours/week: L:1 T:0 P:0 **Marks:** Internal**:100** External**:00** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

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.

SEMESTER – I

24BEMC152	தமிழர் மரபும் பண்பாடும்	1H – 0C

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

End Semester Exam: 3 Hours

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:

1. இந்தியக்குடியுரிமைப்பணி முதலான போட்டித்தேர்வுகளில், விருப்பப்பாடமாக இடம்பெறுகின்ற, 'தமிழ்இலக்கியவரலாறு' குறித்த முழுமையான அறிமுகம் பெற்றிருத்தல்.
2. கல்வெட்டியல், ஓலைச்சுவடியியல் மற்றும் தொல்லியல் சார்ந்த ஆவணத்தேடலுக்குரிய ஆய்வுமனப்பான்மையுடன், இலக்கியங்களை அணுகுதல்.
3. தமிழின்வளர்ச்சித்துறையாகிய, 'அறிவியல்தமிழ்'; 'இணையதமிழ்' குறித்த பன்நோக்கு அணுகுமுறையிலான ஆய்வுச்சிந்தனை மேம்பாடு.
4. வேலைவாய்ப்புக்குரிய சுயதிறன் மேம்பாட்டுடன், படைப்பாக்கத்திறன் மேம்பாடும் பெற்றிருத்தல் .
5. சமுதாய மற்றும் வாழ்வியல் மதிப்புகளைப்பேணுவதற்குக்கருவியாக இலக்கியங்களை நாடுகின்ற மனப்பான்மைவளர்ச்சி. மொழிபெயர்ப்புத்துறை சார்ந்த வேலைவாய்புத்திறன் பெற்றிருத்தல்.

அலகு:1 தமிழர் மரபு

மரபு-விளக்கம்-சங்ககால தமிழர் மரபு – திணைப்பகுப்பும் தமிழர் மரபும்-உலகப்பொதுமை – அகத்திணை மரபு – புறத்திணை மரபு-இடைக்காலத்தமிழர் மரபு – பிற்கால மரபும் மாற்றமும் – தற்கால தமிழர்மரபு - வளர்ச்சி.

அலகு: 2 தமிழர் பண்பாடு

பண்பாடு – விளக்கம் – பழந்தமிழர் பண்பாடு – இயற்கை சார்ந்த வாழ்வியல் – தமிழர் சமயம் – அரசியல் நிலை–சமூகப் பழக்கவழக்கங்கள் – நம்பிக்கைகள் – வாழ்வியல் அறங்கள் – வணிகம் போன்றவை.

அலகு:3 தமிழர் கலைகள்

தமிழகத்தில் கலைகளின் வளர்ச்சி – சிற்பக்கலை வளர்ச்சி –கோயில் கலை – கற்கோவில்கள் - ஓவியக்கலை – அழகுக்கலைகள் - கூத்துக்கலை – மருத்துவக்கலை – நாடகக்கலை– இசைக்கலை போன்றவை.

அலகு: 4 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: 5 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.

SEMESTER – II

24BECC201 TECHNICAL ENGLISH – II 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Technical English - I

COURSE OBJECTIVES:

The goal of this course is for the students to

- To acquire the context of grammar and the importance of Listening, Speaking, Reading and Writing
- To understand and develop critical Listening, Speaking, Reading, and Writing skills
- To apply students' capability to listen vigilantly, read proficiently, innovative writing, and speak fluently

COURSE OUTCOMES:

Upon completion of this course the students 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**

UNIT I **9**

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 **9**

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 **9**

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 **9**

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 **9**

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

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.

WEBSITE URLs:

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

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C107.1	-	-	-	-	2	-	-	2	2	2	-	2	1	-
C107.2	-	-	-	-	2	-	-	2	2	2	-	2	2	1
C107.3	-	-	-	-	2	-	-	2	2	2	-	2	2	1
C107.4	-	-	-	-	2	-	-	2	2	2	-	2	2	1
C107.5	-	-	-	-	2	-	-	2	2	2	-	2	2	1
C107	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**2**	**2**	**-**	**2**	**1.8**	**1**

SEMESTER – II

24BECC202C TRANSFORMS AND ITS APPLICATIONS 4H – 4C

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

End Semester Exam: 3 Hours

Pre-Requisites: 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.
- To provide knowledge of Fourier series techniques in solving heat flow problems and wave equations.
- To acquaint Fourier transforms techniques used in various applications.
- To 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 Hours: 45+15

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 Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C108.1	2	1	-	-	-	-	-	-	-	-	-	1	1	-
C108.2	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C108.3	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C108.4	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C108.5	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C108	**2.8**	**1.8**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**

24BEME203 PHYSICS FOR MECHANICAL ENGINEERS 3H – 3C

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

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The Goal of this course is for students to

- Impart the basic knowledge about thermal properties, ultrasonics and its applications.
- Disseminate the magnetic and super conducting properties of materials and their applications.
- Introduce the essential principles of advanced materials for engineering applications

COURSE OUTCOMES:

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

- Disseminate the fundamentals of thermal physics and their applications **(K2)**
- Explain the concepts of piezoelectric and magnetostriction effect for production of ultrasonic waves (**K2)**
- Interpret the properties of magnetic and superconducting materials **(K2)**
- Infer the types of advanced materials **(K2)**
- Summarize the characterization techniques to understand the properties of materials **(K2)**

UNIT I – THERMAL PHYSICS 9

Mode of Heat Transfer - conduction, convection, radiation (qualitative) - thermal expansions of solid - bimetallic strips – thermal conductivity: rectilinear flow of heat along a uniform bar- Forbe's and Lee's Charlton's disc method: theory and experiment – heat conduction through compound media (series and parallel) – High temperature furnaces

UNIT II ULTRASONICS 9

Ultrasonics – Production – Magnetostriction effect – Magnetostriction generator – Piezoelectric effect – Piezoelectric generator – Detection of ultrasonic waves – Cavitations – Velocity measurement of ultrasonic waves – Industrial applications – Drilling, welding, soldering and cleaning – SONAR – Non-Destructive Testing – Pulse echo system through transmission and reflection modes – Ultrasonic imaging system – Medical applications –Sonograms

UNIT III MAGNETIC AND SUPER CONDUCTING MATERIALS 9

Magnetic moment, magnetic dipoles - magnetic permeability and susceptibility, types of magnetic materials - Ferromagnetism, Domain Theory, Hysteresis on the basis of domains, hysteresis loss, soft and Hard magnetic materials - Superconductivity – Properties – Meissner effect – Effect of magnetic field – Types of superconductors – BCS theory of superconductivity — Applications of superconductors, cryotron and magnetic levitation.

UNIT IV ADVANCED MATERIALS 9

Mechanical properties of ceramics – Types and application of ceramics in automobile industry – Mechanical behavior of polymer – Types and applications of polymer – Mechanical properties of composites – Types – Composites in aerospace and transportation – Metallic glasses – Preparation – Properties and applications – Biomaterials – Types and applications.

UNIT V MATERIAL CHARACTERIZATION 9

X-ray diffraction (XRD) technique – Microscopy techniques – Optical microscopy (OM) – Scanning electron microscopy (SEM) – Transmission electron microscopy (TEM) – Construction – Working – Application.

Total Hours: 45

TEXT BOOKS:

1. V.Raghavan, “Materials Science and Engineering”, 6th Edition. PHI Learning Private Limited, 2015.
2. V.Rajendran, “Materials Science”, 1st Edition. Tata McGraw-Hill, 2012.
3. S.O. Pillai, “Solid State Physics”, 9th Edition. New Age International Publishers, 2020.
4. Mechanics- Berkeley Physics Course Vol(1)- SI units Charles Kittel et al, McGraw Hill Education (India) 2e (2011).
5. Kulkarni, Sulabha K, Nanotechnology: Principles and Practices, Springer International Publishing, (2015).

REFERENCES:

1. Halliday.D. Resnick R. & Walker. J, Principles of Physics, Wiley, (2015).

WEBSITES

1. www.nptel.ac.in/courses/122104014/
2. www.nptel.ac.in/courses/118104008/
3. www.nptel.ac.in/courses/115101012/

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C109.1	2	2	-	-	-	-	-	1	-	-	-	1	1	1
C109.2	2	2	-	-	-	-	-	1	-	-	-	1	1	1
C109.3	2	2	3	-	-	-	1	-	-	-	-	1	1	1
C109.4	2	2	3	1	-	-	1	-	-	-	-	1	1	1
C109.5	2	2	-	1	-	-	1	-	-	-	-	1	1	1
C109	**2.0**	**2.0**	**3.0**	**1.0**	**-**	**-**	**1.0**	**1.0**	**-**	**-**	**-**	**1.0**	**1.0**	**1.0**

SEMESTER – II

24BECC204	ENGINEERING GRAPHICS	3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Mathematics at 10+2 level or equivalent level

COURSE OBJECTIVES:

The goal of this course is for the students to

- To introduce the concepts of geometrical construction to construct projection of curves, points, lines and plane surfaces
- To understand the basic principles in projections of solids, section of solids and development of surfaces
- To familiarize with isometric and perspective projections

COURSE OUTCOMES:

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

CO1:	Construct various conical sections	K3
CO2:	Apply the concepts of drawing conventions, standards and projections in a drawing	K3
CO3:	Develop simple solids and surface	K3
CO4:	Construct the projection of sectioned solids and development of surfaces	K3
CO5:	Design simple solids using CAD packages	K3

CONCEPT AND CONVENTIONS (Not for Examinations)

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions andspecifications – Size, layout and folding of drawing sheets – Lettering and Dimensioning.

UNIT I PLANE CURVES AND FREE HAND SKETCHING 6

Basic Geometrical constructions, Curves used in Engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – Construction of involutes of Square, Pentagon, Hexagon and Circle – Drawing of tangents and normal to the above curves – Orthographic projection – First angleprojection – Free hand sketching of multiple views from pictorial views of objects.

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACES 6

Projection of points – Projection of straight lines (only First angle projections) inclined to both the principal planes.

Determination of true lengths and true inclinations by rotating line method and traces – Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS 6

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 6

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planesand perpendicular to the other – Obtaining true shape of section – Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids, cylinders and cones.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6

Principles of isometric projection – Isometric scale – Isometric projections of simple solids and truncated solids – Prisms, pyramids, cylinders, cones – Combination of two solid objects in simple vertical position – Perspectiveprojection of simple solids – Prisms, pyramids and cylinders by visual ray method – Practicing three-dimensionalmodelling of isometric projection of simple objects by CAD software (Not for examination).

TOTAL: 30+15 PERIODS

TEXT BOOKS:

1.K V Natarajan, "A Text book of Engineering Graphics", 5th Edition, Dhanalakshmi Publishers, 2020.
2.K Morling, "Geometric and Engineering Drawing", 4th Edition, Routledge Publications, 2022.

REFERENCE BOOKS:

1.K Venugopal and V Prabhu Raja, "Engineering Drawing and Graphics", 6th Edition, New Age, 2022.
2.Dhananjay Jolhe, "Engineering Drawing with an introduction to AutoCAD", 1st Edition, McGraw Hill, 2018.
3.Basant Agarwal and C M Agarwal, "Engineering Drawing" 3rd Edition, McGraw Hill, 2019.
4.S N Lal, "Engineering Drawing with an Introduction to AutoCAD: First-angle Projection", 1st Edition,Cengage Learning India, 2018.
5.Colin Simmons, Dennis Maguire and Neil Phelps, "Manual of Engineering Drawing", 5th Edition,Butterworth-Heinemann, 2020.

WEB URLs:

1.www.iitg.ernet.in/rkbc/me111.htm
2.www.iitg.ac.in/rkbc/ME111/Lecture14 Development of surfaces-pkghosh.pdf
3.www.iitg.ac.in/dsharma/me111/Lecture 1 Introduction.pdf

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C110.1	3	2	1	-	-	-	-	-	2	1	-	1	1	1
C110.2	3	2	1	-		-	-	-	2	1	-	1	1	1
C110.3	3	2	1	-	-	-	-	-	2	1	-	1	1	1
C110.4	3	2	1	-	-	-	-	-	2	1	-	1	1	1
C110.5	3	2	1	-	1	-	-	-	2	1	-	1	1	1
C110	**3**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**2**	**1**	**-**	**1**	**1.0**	**1.0**

SEMESTER – II

24BECC205 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING 3H – 3C

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

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To impart the basic knowledge about the Electric circuits and concept of Electrical Machines and Transformers.
- To understand the working of Semiconductor devices and Digital Circuits.
- To impart the basic knowledge of Measuring Instruments and Electrical Installation.

COURSE OUTCOMES:

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

- Summarize the basic laws and theorems of DC circuit
- Compare single phase and three phase AC circuits
- Explain the construction and working of induction motor, DC motor and transformers
- Illustrate Bipolar Junction Transistor, Operational Amplifier and logic gates
- Outline the operations of measuring instruments and components of electrical installation.

UNIT I DC CIRCUITS **9**

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff's current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin's and Norton Theorems.

UNIT II AC CIRCUITS **9**

Representation of sinusoidal waveforms, peak and rms values, Phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.

UNIT III - ELECTRICAL MACHINES AND TRANSFORMER **9**

Construction and working of a three-phase and Single-phase induction motor. Construction, working and speed control of DC motor. Magnetic materials, BH characteristics, Construction and working principle of ideal and practical transformer.

UNIT IV- SEMICONDUCTOR DEVICES AND DIGITAL ELECTRONICS **9**

Bipolar Junction Transistor – Characteristics. Introduction to operational Amplifier –Model– Applications. Number systems – binary codes - logic gates - Boolean algebra, laws & theorems

UNIT V- MEASURING INSTRUMENTS AND ELECTRICAL INSTALLATION **9**

Principle, construction, and operation of moving coil and moving iron meters-Measurement of Power. Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, RCCB, MCCB. Earthing. Types of Batteries and its application in Electric Vehicle, Important Characteristics for Batteries. Elementary calculations for energy consumption and battery back up.

TEXT BOOKS

1. S.K.Bhattacharya, “Basic Electrical Engineering”, Pearson, 2019.
2. E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.
3. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010
4. VN Mittle and Arvind Mittal, (2006), Basic Electrical Engineering, McGraw Hill.

WEB LINKS:

1. www. nptel.ac.in.
2. encyclopedia-magnetica.com/doku.php/co energy.
3. https://en.wikibooks.org/wiki/electronics/measuringinstruments.

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C111.1	2	1	-	-	-	-	-	-	2	2	-	1	1	-
C111.2	2	1	-	-	-	-	-	-	2	2	-	1	1	-
C111.3	2	1	-	-	-	-	-	-	2	2	-	1	1	-
C111.4	2	1	-	-	-	-	-	-	2	2	-	1	1	-
C111.5	2	1	-	-	-	-	-	-	2	2	-	1	1	-
C111	**2.40**	**1.40**	**-**	**-**	**-**	**-**	**-**	**-**	**2.00**	**2.00**	**-**	**1.00**	**1.00**	**-**

SEMESTER – II

24BECC241 ENGINEERING CHEMISTRY 5H – 4C

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

End Semester Exam: 3 Hours

(i) THEORY

COURSE OBJECTIVES:

The goal of this course is 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 9

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 9

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 9

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 9

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 9

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 Hours: 45+30

TEXT BOOKS:

1. P C Jain & Monica Jain, (2022). Engineering Chemistry, 18th edition, Dhanpat Rai Publishing Company
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, (2010). University chemistry, Pearson Education.
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, (1976) Chemistry: Principles and Applications. 5th edition, McGraw-Hill Higher Education.
2. C. N. Banwell, (2001) Fundamentals of Molecular Spectroscopy, McGraw-Hill.
3. P. W. Atkins, (2022) Physical Chemistry, Oxford University Press.
4. B. L. Tembe, Kamaluddin and M. S. Krishnan, Engineering Chemistry (NPTEL Web- book)
5. K. P. C. Volhardt and N. E. Schore, (2014). 5th Edition, Organic Chemistry: Structure and Function, W.H. Freeman Publications.

WEB REFERENCES:

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

(ii) LABORATORY

LIST OF EXPERIMENTS – CHEMISTRY

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 Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C112.1	3	2	1	-	-	1	1	1	1	-	-	1	-	1
C112.2	2	1	-	-	-	1	1	1	1	-	-	1	-	1
C112.3	2	1	-	-	-	1	1	1	1	-	-	1	-	1
C112.4	2	1	-	-	-	1	1	1	1	-	-	1	-	1
C112.5	3	2	-	-	-	1	1	1	1	-	-	1	-	1
C112	2.4	1.4	1	-	-	1	1	1	1	-	-	1	-	1

SEMESTER – II

24BECC211	**COMMUNICATION SKILLS LABORATORY**	**2H – 1C**

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

End Semester Exam: 3 Hours

Pre-Requisites: None

COURSE OBJECTIVES:

The goal of this course is 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**

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

SEMESTER – II

24BEMC251	**YOGA**	**4H – 2C**
Instruction Hours/week: L:0 T:0 P:4	**Marks:** Internal**:40** External**:60 T**otal**:100**	
	End Semester Exam: 3 Hours	

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 V.K.Sharma, Health and Physical Education, NCERT Books; Class11,12 Saraswati House Publication, New Delhi
3. Acharya Yatendra, Yoga and Stress Management, Fingerprint Publishing ISBN: 938905303X
4. Swami Vivekanand, Patanjali Yoga Sutras, Fingerprint Publishing ISBN 9389567351.
5. Ramdev, Pranayam Rahasya, Patanjali-Divya Prakashan, Haridwar ISBN: 9788189235017
6. Ramdev, Yoga its Philosophy & Practice, Divya Prakashan, Haridwar.

SEMESTER – III

24BEME301B	NUMERICAL METHODS	4H – 4C

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

End Semester Exam: 3 Hours

Pre-Requisites: Transforms and Its Applications

COURSE OBJECTIVES:

The goal of this course is for students:

- To inculcate the basic concepts of solving algebraic and transcendental equations.
- To understand the numerical techniques of interpolation in various intervals
- To provide the knowledge of numerical differentiation and integration
- To provide the knowledge of solving ordinary differential equations and partial differential equations numerically

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)**

UNITI 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 hours:45+15

TEXT BOOKS:

1. Steven C.Chapra, Raymond P.Canale, Numerical Methods for Engineers,8th Edition , Tata McGraw Hill Education,2021.

2. Curtis F. Gerald and Patrick O. Wheatley,Applied Numerical Analysis,Addison Wesley, Thirteenth Edition,2004.

REFERENCE BOOKS:

1. Richard L. Burden and J. Douglas Faires, Numerical Methods, 4th Edition, Brooks/Cole 2012.

2. Boyce, Di Prima and Meade, "Elementary Differential Equations and Boundary value problem", 12th Edition, John Wiley & Sons, 2021.

3. Steven Chapra, "Applied Numerical Methods with MATLAB", 5th Edition, Mcgraw-Hill Education, 2022.

4. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, Tenth Edition, 2011.

WEBSITES:

1. www.classcentral.com/course/numerical-methods-engineers-32822
2. http://www.infocobuild.com/education/audio-video-courses/mathematics/numerical-analysis-iit-madras.html
3. http://www.infocobuild.com/education/audio-video-courses/mathematics/NumericalMethods-FiniteDifference-IIT-Roorkee/lecture-06.html

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C201.1	3	2	1	-	-	-	-	-	-	-	-	1	1	1
C201.2	3	2	1	-	-	-	-	-	-	-	-	1	1	1
C201.3	3	2	1	-	-	-	-	-	-	-	-	1	1	1
C201.4	3	2	1	-	-	-	-	-	-	-	-	1	1	1
C201.5	3	2	1	-	-	-	-	-	-	-	-	1	1	1
C201	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**

SEMESTER – III

24BEME302 ENGINEERING MECHANICS 4H – 4C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Mathematics and Physics at 10+2 level or equivalent level

COURSE OBJECTIVES:

The goal of this course is for students:

- To understand the basic concept of equilibrium of particles and rigid bodies
- To familiarize with properties of sections, motion equations and momentum principle
- To get basic idea of static friction

COURSE OUTCOMES:

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

CO1:	Identify the behavior of static and dynamic bodies	K3
CO2:	Calculate the forces acting on rigid bodies	K3
CO3:	Develop the properties of standard surfaces and solids	K3
CO4:	Solve the dynamic forces exerted in rigid body	K3
CO5:	Apply the effects of friction on a rigid body	K3

UNIT I BASICS AND STATICS OF PARTICLES 9

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces – Vector operations of forces – Additions, subtraction, dot product, cross product – Coplanar Forces – Rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility.

UNIT II EQUILIBRIUM OF RIGID BODIES 9

Free body diagram – Types of supports – Action and reaction forces – Stable equilibrium – Moments and Couples -Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force – Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions.

UNIT III PROPERTIES OF SURFACES AND SOLIDS 9

Centroids and centre of mass – Centroids of lines and areas – Rectangular, circular, triangular areas by integration T section, I section, Angle section, Hollow section by using standard formula – Theorems of Pappus – Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem -Principal moments of inertia of plane areas – Principal axes of inertia.

UNIT IV DYNAMICS OF PARTICLES 9

Displacements, velocity and acceleration and their relationship – Relative motion – Curvilinear motion – Newton's laws of motion – Work Energy Equation – Impulse and Momentum – Impact of elastic bodies.

UNIT V FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS 9

Friction force – Laws of sliding friction – Equilibrium analysis of simple systems with sliding friction – Wedge friction, rolling friction and ladder friction – Rolling resistance – Translation and rotation of rigid bodies, Velocity and acceleration – General plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

TOTAL: 45+15 PERIODS

TEXT BOOKS:

1. P Ferdinand Beer, E Russell Johnston, David Mazurek, J Phillip Cornwell, Brian Self and Sanjeev Sanghi, "Vector Mechanics for Engineers: Statics and Dynamics", 12th Edition, McGraw Hill, 2019.
2. R K Bansal, "A Text book of Engineering Mechanics", 8th Edition, Laxmi Publishers, 2018.

REFERENCE BOOKS:

1. K L Kumar and Veenu Kumar, "Engineering Mechanics", 4th Edition, McGraw Hill, 2018.
2. C Russell Hibbeler, "Engineering Mechanics: Principles of Statics and Dynamics", 14th Edition, PrenticeHall, 2019.
3. Daniel Kleppner and Robert J Kolenkow, "Introduction to Mechanics", 2nd Edition, Cambridge UniversityPress, 2021.
4. J L Meriam, L G Kraige and J N Bolton, "Engineering Mechanics Statics and Dynamics (An IndianAdaptation)", 9th Edition, Wiley India, 2021.
5. Bhavikatti, "Engineering Mechanics", 8th Edition, New Age International Publishers, 2022.

WEB URLs:

1. www.iitg.ac.in/rkbc/me101/Presentation/L01-03.pdf
2. www.cc.gatech.edu/classes/AY2012/cs4496_spring/slides/Particles.pdf
3. www.civil.iitb.ac.in/~minamdar/ce102/Files/Friction.pdf

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C202.1	3	2	1	-	-	-	-	-	-	1	-	1	1	-
C202.2	3	2	1	-	-	-	-	-	-	1	-	1	1	-
C202.3	3	2	1	-	-	-	-	-	-	1	-	1	1	-
C202.4	3	2	1	-	-	-	-	-	-	1	-	1	1	-
C202.5	3	2	1	-	-	-	-	-	-	1	-	1	1	-
C202	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**-**

SEMESTER – III

24BEME303 MANUFACTURING PROCESSES 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Workshop Practices Laboratory

COURSE OBJECTIVES:

The goal of this course is for students:

- To gain knowledge on moulding techniques
- To learn the principles of welding sheet metal and forging
- To impart knowledge on manufacturing of plastic components

COURSE OUTCOMES:

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

CO1	Classify casting methods to produce components	K2
CO2	Compare various welding techniques.	K2
CO3	Explain process requirements for fabricating sheet metal	K2
CO4	Illustrate the various forging methods.	K2
CO5	Summarize manufacturing processes to produce plastic components	K2

UNIT I CASTING 9

Introduction to casting – Sand casting – Sand moulds – Type of patterns – Pattern materials – Pattern allowances – Types of Moulding sand – Properties – Evaluation of characteristics of Moulding sand – Preparation of green sand mould – Core making – Methods of sand testing – Moulding machines – Melting furnaces – Cupola Furnace – Electric Arc Furnace – Casting an component – Special casting methods – Shell and investment casting – Pressure die casting – Centrifugal casting – CO_2 process – Sand casting defects – Inspection methods.

UNIT II WELDING 9

Fusion welding processes: Types of Gas welding – Equipment's used – Flame characteristics – Filler and Flux materials – Arc welding equipment's – Electrodes – Coating and specifications – Gas metal arc welding – Submerged arc welding – TIG welding–Resistance welding – Spot/butt, seam welding – Friction stir welding – Weld defects.

UNIT III SHEET METAL 9

Sheet metal characteristics – Shearing, bending and drawing – Stretch forming – Sheet metal operations – Blanking – Fine blanking – Piercing – Punching – Trimming – Shaving – Nibbling – Notching – Embossing and coining.

UNIT IV FORGING 9

Hot and cold working: Forging – Open die forging – Closed die forging – Press forging – Upset and roll forging – Rolling – Cold and hot rolling – Rolling of metals – Types of Rolling mills – Flat strip rolling – Shape rolling operations – Defects in rolled parts – Drawing and deep drawing processes – Tube drawing – Principles of Extrusion – Types of Extrusion – Hot and Cold extrusion.

UNIT V MANUFACTURING OF PLASTIC COMPONENTS 9

Types and characteristics of plastics – Moulding of thermoplastics – Injection moulding – Compression moulding – Transfer Moulding – Typical industrial applications – Introduction to blow moulding – Rotational moulding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics.

TOTAL: 45

TEXT BOOKS:

1. R K Rajput, "A Textbook of Manufacturing Technology: Manufacturing Processes", Laxmi publications, 2nd Edition, 2018.
2. P C Sharma, "A Text Book of Production Technology", S Chand, 8th Edition 2014.

REFERENCE BOOKS:

1. Serope Kalpakian and Steven R Schmid, "Manufacturing Engineering and Technology, Addison Wesley, 7th Edition, 2013.
2. P N Rao, Manufacturing Technology, Tata McGraw Hill, 4th Edition, 2013.
3. Hajra Choudhry S K Elements of Workshop Technology. Vol. I: Manufacturing Processes Media Promoters, 1st Edition, 2010.

WEB URLs:

1. www.cedengineering.com/userfiles/Manufacturing Metal Castings.pdf
2. www.nptel.ac.in/courses/107103012/module6/lec1.pdf
3. www.nptel.ac.in/courses/112107144/6

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C203.1	2	1	-	-	-	-	-	-	-	1	-	1	1	-
C203.2	2	1	-	-	-	-	-	-	-	1	-	1	1	1
C203.3	2	1	-	-	-	-	-	-	-	1	-	1	1	-
C203.4	2	1	-	-	-	-	-	-	-	1	-	1	1	-
C203.5	2	1	-	-	-	-	-	-	-	1	-	1	1	-
C203	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**1**

SEMESTER – III

24BEME304 ENGINEERING THERMODYNAMICS 4H – 4C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Transforms and its applications and Physics for Mechanical Engineers.

COURSE OBJECTIVES:

The goal of this course is for students:

- To acquire knowledge on principles of thermodynamics
- To study vapour power cycles and properties of gas mixtures
- To make use of psychrometric charts

COURSE OUTCOMES:

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

CO1:	use the fundamental laws of thermodynamics in engineering applications	K3
CO2:	apply work and heat interactions associated within a prescribed process path	K3
CO3:	evaluate the performance of vapour power cycles	K3
CO4:	interpret the significance of thermodynamic relations	K3
CO5:	solve problems on psychromtery	K3

UNIT I BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS 9

Basic concepts of Thermodynamics – Types of systems – Properties of a system – State and equilibrium – Processes and cycles – Forms of energy – Work and heat transfer – Temperature and Zeroth law of thermodynamics – First law of thermodynamics – Energy balance for closed systems – First law applied to steady flow engineering devices.

UNIT II SECOND LAW OF THERMODYNAMICS 9

Limitations of the first law of Thermodynamics – Thermal energy reservoirs – Second law statements: Kelvin Planck and Clausius statements – Equivalence – Heat Engine, Refrigerators, Heat Pump – COP – Perpetual Motion Machines – Reversible and Irreversible process – Carnot cycle – Entropy – Change in entropy for various thermodynamic processes – The Clausius inequality – Availability and irreversibility – Entropy generation – Causes of irreversibility – Second law efficiency – Third law of thermodynamics.

UNIT III VAPOUR POWER CYCLES 9

Properties of pure substance – Property diagram for phase change processes – Thermodynamic properties of steam – Dryness fraction – Rankine cycle – Effect of pressure and temperature on the Rankine cycle – Methods for improving the efficiency of Rankine cycle – Variables affecting the efficiency of Rankine cycle – Ideal reheat and Regenerative cycles.

UNIT IV PROPERTY RELATIONS AND IDEAL GAS MIXTURES 9

Maxwell relations – Verification – Clausius Clapeyron equation – Calculation of steam properties – Properties of Ideal gas – Ideal and real gas comparison – Equations of state for ideal and real gases – Reduced properties – Compressibility factor – Principle of corresponding states – Generalized compressibility chart and its use – Composition of gas mixtures – Mass and mole fractions – Dalton's law of additive pressure – Internal energy – Enthalpy – Entropy and specific heats.

UNIT V PSYCHROMETRY 9

Psychrometric properties – Psychrometric charts – Property calculations of air vapour mixtures by using chart and expressions – Psychrometric processes – Adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing – Simple applications.

TOTAL: 45+15

TEXT BOOKS:

1. P K Nag, "Engineering Thermodynamics", 6th Edition, McGraw Hill Publishers, 2022.
2. A Yunus Cengel and A Michael Boles, "Thermodynamics: An Engineering Approach", 9th Edition, McGraw Hill Publishers, 2019.

REFERENCE BOOKS:

1. J P Holman, "Thermodynamics", 4th Edition, McGraw Hill Publishers, 2005.
2. C Kothandaraman and S Munawar, "A Course in Thermal Engineering", 1st Edition, Dhanpat Rai Publishers, 2020.
3. J Michael Moran, N Howard Shapiro, D Daisie Boettner and B Margaret Bailey, "Principles of Engineering Thermodynamics", 8th Edition, John Wiley, Publishers, 2019.

WEB URLs:

1. https://www.nptel.ac.in/courses/101104063/
2. https://www.learnthermo.com/tutorials.php
3. https://www.uigi.com/psychrometry.html

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C204.1	2	1	-	-	-	-	-	-	-	-	-	1	3	-
C204.2	2	1	-	-	-	-	-	-	-	-	-	1	3	-
C204.3	3	2	-	-	-	-	-	-	-	-	-	1	3	-
C204.4	3	2	-	-	-	-	-	-	-	-	-	1	3	-
C204.5	3	2	-	-	-	-	-	-	-	-	-	1	3	-
C204	**2.6**	**1.6**	-	-	-	-	-	-	-	-	-	**1**	**3**	-

SEMESTER – III

24BEME305	GRAPHICS, GEOMETRIC TOLERANCES AND DRAWING IN MANUFACTURING	3H – 3C

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

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for students:

- To learn the graphical projection of various engineering components.
- To enlighten the knowledge in CADD and GD&T.
- To provide knowledge in manufacturing drawing for mechanical components.

COURSE OUTCOMES:

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

CO1: Explain the standards and symbols pertaining to the drawing of engineering components and machine elements & manufacturing components K2

CO2: Understand and create any machine drawing irrespective of the manufacturing Processes K2

CO3: Explain the GDT and drawing concepts, to draw the components, production and assembly drawings K2

CO4: Summarize the drawings of complicated machine structures and do the needed Execution K2

CO5: Develop and provide drawings for any Mechanical / Manufacturing Engineering machine parts / components of equipment / products used or developed in manufacturing & process plants with the help of modern software K3

UNIT – I: ENGINEERING GRAPHICAL PROJECTIONS FOR MECHANICAL COMPONENTS 9

Introduction to Engineering Drawing, Geometrical Constructions, Plane Curves, Planes of Projections, Projections of Straight Lines & Inclined Lines, Planes and Solids, Sections of Solids, Developments of Surfaces, Orthographic Views, Isometric Projections, Perspective Projection. Hands on Training: Draw the Orthographic Views and Sectional Views of a Screw Jack, Knuckle Joint by using AutoCAD. Draw the Isometric View of the Machine Vice Body, Flange Coupling, Plummer Block & Machine Components by using AutoCAD.

UNIT – II: CADD OF MECHANICAL COMPONENTS & BIM 9

Introduction to Computer Aided Design and Drafting, Introduction to AutoCAD, Editing Commands, Draw Commands, Advanced Commands, Dimensioning Commands, 3D Modelling Commands Introduction to Building Information Modeling, BIM Categorization, Levels of BIM, BIM Implementation Departments, BIM Process, BIM Demo.

UNIT – III: GEOMETRIC DIMENSIONING & TOLERANCING (GD&T) AND SYMBOLS & STANDARDS 9

Introduction to Geometric Dimensioning & Tolerancing (GD&T), Necessity of GD&T, Reference Frame and other Types of Frames, Understandings of Geometric & Dimensional Characteristics, Constraints & Symbols, Symbol of Surface Texture for Machining and other fabrication process, Different Types of Drawings & Layouts, Limits, Fits and Tolerance, Case Study related to GDT, Introduction to Welding Symbols & Standards, Welded, Brazed and Soldered Joints, Case Studies related to Drawings and Layouts.

UNIT – IV: DRAWINGS OF TEMPORARY JOINTS, FASTENERS AND DIES 9

Introduction of various elements required for Fasteners, Symbolic representation – Fastener (Bolts, Nuts, Screws), Drawings of Keys, Bearings, Universal Joints, Couplings, Case Study related to Temporary Joint Components. Standards & symbols followed in the Mold Design for Casting Process, Drawing for Metal Forging process, Drawing for Sheet Rolling process, Case Study related to drawings of Casting, Forging and Forming process.

UNIT – V: MANUFACTURING DRAWINGS OF PROCESS EQUIPMENT & PIPING 9

Pressure Vessel, symbols and standards, Layout drawings, Production and Assembly drawings, Drafting Nozzles and heads, Welding details, vessel support systems, Materials and design consideration, Drafting a detailed drawing of few pressure vessels. Heat Exchangers, Tube bundle and shell assembly drawing, Materials, Codes and standards, and Detailed drawing of Heat exchangers Over view of Industrial valves, Valve Body, Valve Trim and Valve Bonnet diagrams and detailed drawings of Industrial valves, Material specification, standards, Symbols and codes for the drawings of Industrial valves Industrial Piping, Pipe fittings, supports, codes and specifications, Fabrication and Installation Drawings.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. John K C ,Textbook of Machine Drawing, PHI Learning, April 2009.
2. Trymbaka Murthy S,Textbook of Computer Aided Machine Drawing" by Murthy, Medtech Publishers,2019.
3. Gill P S, Textbook of Machine Drawing" by S K Kataria and Sons, 2010.

REFERENCE BOOKS:

1. N. D. Bhatt ,"Machine Drawing, Charotar Publishing House, 2014.
2. K R Gopalkrishna, Machine Drawing, 2017.
3. Roy A. Parisher ,Pipe Drafting and Design, Elsevier; 3rd edition,2011.
4. George Omura ,Mastering AutoCAD 2019 and AutoCAD LT 2019-, Sybex; 1st edition, 2018.

SEMESTER – III

24BEME341 FLUID MECHANICS AND FLUID MACHINES 5H – 4C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Matrices and Calculus

COURSE OBJECTIVES:

The goal of this course is for students:

- To acquire knowledge on fluid flow characteristics
- To study the laws governing fluid motion and its applications in fluid machines
- To learn the concept of fluid mechanics and machinery.

COURSE OUTCOMES:

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

CO1:	Interpret the fluid properties and its applications	K3
CO2:	Apply the fluid flow governing equations	K3
CO3:	Develop fluid flow equation using dimensional analysis	K3
CO4:	Compare the performance of hydraulic turbines	K4
CO5:	Distinguish the characteristics of hydraulic Pumps.	K4

UNIT I PROPERTIES OF FLUID AND FLUID STATICS 9

Concepts of Fluid continuum – Properties of fluids – Density, viscosity, compressibility, capillarity and surface tension – Fluid statics – Hydrostatic force on inclined and curved surfaces – Pressure measurements – Buoyancy.

UNIT II KINEMATICS AND DYNAMICS OF FLUID FLOW 9

Fluid Kinematics – Eulerian and Lagrangian approach – Classification of fluid flows – Velocity and acceleration in fluid – Continuity equation – Fluid dynamics – Equations of motion – Euler's equation – Bernoulli's equation and its applications.

UNIT III DIMENSIONAL ANALYSIS, FLOW THROUGH PIPES AND BOUNDARY LAYER 9

Dimensional analysis – Buckingham's Π theorem – Model testing and Dimensionless numbers – Viscous flow – Navier-Stoke's equation (without proof) – Hagen Poiseulle's – Darcy-Weisback's equation – Losses in pipes – Pipe network design – Boundary layer flows, boundary layer thickness – Drag and lift coefficients.

UNIT IV TURBINES 9

Impact of Jet – Construction of velocity vector diagrams – Head and specific work – Pelton turbine – Modern Francis turbine – Propeller turbine – Kaplan turbine – Working principles.

UNIT V PUMPS 9

Pumps – Classifications of pumps – Centrifugal pump – Working principle – Velocity triangles – Specific speed – Efficiency – Reciprocating pump – Classification – Working principle – Indicator diagram – Work saved by air vessels – Cavitation in pumps – Rotary pumps – Working principles of gear and vane pumps.

LIST OF EXPERIMENTS:

1. Estimate the coefficient of discharge Venturimeter,
2. Estimate the coefficient of discharge Orifice meter
3. Estimate the error percentage of Rotameter.
4. Performance parameters of Pelton wheel turbine.
5. Performance test on Francis turbine.
6. Performance test on centrifugal pump.
7. Performance test on reciprocating pump.
8. Conducting experiments to draw the operating characteristic curve of gear pump.
9. Conducting experiments to draw the operating characteristic curve of submersible pump.

TOTAL: 45+20

TEXT BOOKS:

1. R K Bansal, "Fluid Mechanics and Hydraulics Machines", 9th Edition, S Chand, 2019.
2. F M White, "Fluid Mechanics", 9th Edition, Tata Mc Graw Hill, 2022.

REFERENCE BOOKS:

1. K Kumar L, "Engineering Fluid Mechanics", 9th Edition, S Chand, 2017
2. P N Modi and S M Seth, "Hydraulics and Fluid Mechanics", 22nd Edition, Rajsons Publications, 2019.
3. S Ramamrutham and R M Narayan, "Hydraulics, Fluid Mechanics and Fluid Machines" 9th Edition, Dhanpat Rai Publishing, 2019.

WEB URLs:

1. https://www.archive.nptel.ac.in/content/storage2/courses/112104118/lecture-5/5-4_buoyancy.htm
2. https://www.usgs.gov/media/images/three-gorges-dam-china-worlds-largest-hydro-facility
3. https://www.modernpumpingtoday.com/a-new-approach-to-accurate-water-flow-measurement/

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C206.1	3	2	1	-	-	-	-	-	-	-	-	2	2	-
C206.2	3	2	1	-	-	-	-	-	-	-	-	2	2	-
C206.3	3	2	1	-	-	-	-	-	-	-	-	2	2	-
C206.4	3	3	2	1	-	-	-	-	-	-	-	2	2	-
C206.5	3	3	2	1	-	-	-	-	-	-	-	2	2	-
C206	**3**	**2.4**	**1.4**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**

SEMESTER – III

24BEME311 SKILL DEVELOPMENT – I 2H – 1C

WELDING PROCESS AND INSPECTION

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

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The goal of this course is for students to

- Identify the scope of the problem in the defined area.
- Use the tools required for the defined problem.
- Experiment with the process/methodology for the defined problem.

COURSE OUTCOMES

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

- Explain the working principles of SMAW, SAW, GMAW, FCAW and GTAW processes
- Classify different welding electrodes and consumables.
- Describe the effects of heat treatment on weldments.
- Interpret welding symbols in technical drawings with ASME Sec IX standards.
- Explain the principles and techniques of welding inspection.

UNIT I ARC WELDING

Arc Welding sources - SMAW Process - Equipment, Techniques & Electrodes Classification - SAW Process - Principle, Equipment, Techniques, Consumable and Applications.

UNIT II GAS WELDING

Basics of Gas Welding - GMAW - Principle, Equipment, Techniques, Consumables and Applications - GTAW Process - Principle, Equipment, Techniques, Consumables and Applications - Weldability of steels.

UNIT III WELDING SYMBOLS AND TREATMENTS

Heat treatment of weldments - Weld Joint Design & Welding symbols - Welding procedure specification as per ASME Sec IX - Mechanical and Metallurgical testing of welds.

UNIT IV WELDING DEFECTS

Weld discontinuities, types, causes and remedies - Definition and significance of welding defects - Classification of welding defects - External Defects - Porosity, Undercut, Overlap, Cracks, Spatter, Incomplete fusion - Internal Defects - Slag inclusions, Incomplete penetration, Root cracks, Shrinkage cavities, Gas.

UNIT V WELDING INSPECTION AND TESTING

Visual inspection - Non-Destructive Testing - Penetrant test, Magnetic Particle test, Radiographic Testing test, Ultrasonic Testing - Destructive Testing - Tensile test, Bend test, Fracture test.

Assessment Methods: At the end of the training programme, the participants are required to appear for the examination consisting of theory as well as practical sessions.

SUGGESTED READINGS

1. V.M. Radhakrishnan, "Welding Technology and Design", New Age International Private Limited, 2012.
2. E.N. Gregory, A.A. Armstrong, "Welding Symbols on Drawings", CRC Press, 2005
3. American Welding Society, "Welding Inspection Technology" American Welding Society Education Services, 2008.

SEMESTER – III

24BEME351 APTITUDE AND REASONING 1H – 0C

Instruction Hours/week: L:1 T:0 P:0 **Marks:** Internal**:100** External**:00 T**otal**:100**

End Semester Exam: 3 Hours

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

- Explain the basics of quantitative ability.
- Solve Logaraithm, Permutation and Combinations, Probability, Basic Accountancy, Time, Speed, distance, work, Ratio and area.
- Utilize satisfactory competency in Verbal Reasonings.
- Solve campus placements aptitude papers covering Quantitative Ability and verbal skills.
- Apply Quantitative and Verbal reasoning in puzzle-related questions.

UNIT - I 1. 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 2. 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 3. Verbal - Aptitude

a. Words
b. Idioms
c. Phrases in Context
d. Reading comprehension techniques
e. Narrative sequencing
f. Data interpretation

TEXTBOOKS:

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/

SEMESTER – IV

24BEME401 ENGINEERING MATERIALS AND METALLURGY 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Physics at 10+2 level or equivalent level

COURSE OBJECTIVES:

The goal of this course is for students to

- To familiarize on phase diagrams and heat treatment processes.
- To learn the properties and characteristics of metallic and non-metallic materials
- To impart knowledge on the various material testing methods

COURSE OUTCOMES:

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

CO1: Explain the binary alloy system's and its phases K2
CO2: Summarize the various heat treatment processes . K2
CO3: Discuss the ferrous and non-ferrous metals with its applications K2
CO4: Explain non-metallic materials and its applications K2
CO5: Outline the testing methods to study the material properties of materials K2

UNIT I ALLOYS AND PHASE DIAGRAMS 9

Solid solutions and its types and intermediate phases - Hume Rothery's rule - solidification of metals and alloys, cooling curves, concepts of phase diagrams, coring and segregation as applied to various binary systems, ternary systems, Iron – Iron carbide equilibrium diagram.

UNIT II HEAT TREATMENT 9

Definition – Full annealing, stress relief, recrystallisation and spheroidizing –normalising, hardening and tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on TTT diagram, CCT - Hardenability, Jominy end quench test – Austempering, martempering – case hardening - carburising, nitriding, cyaniding, carbonitriding – Flame and Induction hardening, Microstructure study and specimen preparation.

UNIT III FERROUS AND NON-FERROUS METALS 9

Effect of alloying additions on steel- α and β stabilizers - stainless and tool steels – HSLA - maraging steels – Gray, White malleable, Spheroidal Graphite irons - Copper and Copper alloys – Brass, Bronze and Cupronickel – Aluminum and Al-Cu – precipitation, strengthening treatment – Bearing alloys, Applications of Ferrous and Non-Ferrous Metals.

UNIT IV NON-METALLIC MATERIALS 9

Polymers – types of polymer, commodity and engineering polymers – Properties and Applications of thermoplastics (PP, PVC, ABS, and PMMA) and thermosetting plastics (PF, UF, MF) – Engineering Ceramics. Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON – Composites Materials - Classifications - Metal Matrix and FRP - Applications of Composites.

UNIT V TESTING OF MATERIALS 9

Mechanism of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), Impact test - Izod and Charpy, Fatigue and creep test, S-N curve.

Non Destructive Testing: Non Destructive Testing basic principles and testing Method of Radiographic testing, Ultrasonic testing, Magnetic particle test and Liquid penetrant test, Eddy current testing.

TOTAL: 45 PERIODS

TEXT BOOKS:

1.R Srinivasan, "Engineering Materials and Metallurgy", McGraw Hill Education, New Delhi, 2009
2.Williams D Callister, “Material Science and Engineering” Wiley India Pvt Ltd, Revised Indian Edition 2014
3.Kenneth G.Budinski and Michael K.Budinski, Engineering Materials: Properties and Selection, 9th Edition, Prentice-Hall of India Private Limited, New Delhi, 2010

REFERENCE BOOKS:

1.William D. Callister and David G. Rethwisch, Fundamentals of Materials Science and Engineering: An Integrated Approach, 5thedition, International Student Version, John Wiley and Sons, Inc., 2016.
2.Raghavan. V, Materials Science and Engineering, 6thedition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
3.James F. Shackelford, Madanapalli K. Muralidhara, Introduction to Materials Science for Engineers, 6th edition, Pearson Education, India, 2014.

WEBSITES:

1.https://www.digimat.in/nptel/courses/video/113102080/L01.html
2.https://www.digimat.in/113.html

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C207.1	2	1	-	-	-	-	-	-	-	1	-	1	1	-
C207.2	2	1	-	-	-	-	-	-	2	2	-	1	1	-
C207.3	2	1	-	-	-	-	-	-	2	2	-	1	1	-
C207.4	2	1	-	-	-	-	-	-	-	1	-	1	1	-
C207.5	2	1	-	-	-	-	-	-	2	2	-	1	1	-
C207	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2.00**	**1.60**	**-**	**1.00**	**1.00**	**-**

SEMESTER – IV

24BEME402 TECHNOLOGY AND PROCESSES IN HEAVY MANUFACTURING 3H – 3C

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

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to

- To inculcate the basics in heavy equipment manufacturing.
- To learn the heavy metal forming and welding technologies.
- To familiarize the parameters of heavy manufacturing and application of fluid power and IoT in heavy manufacturing.

COURSE OUTCOMES:

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

CO1: Summarize the information on various ferrous materials properties and industrial applications K2

CO2: Explain practical knowledge of the various shop floor practices used in the heavy manufacturing K2

CO3: Illustrate the international codes and standards that are used for testing specimens and the significance of using appropriate tools and equipment K2

CO4: Apply an Industrial Application Circuit for machining process and fluid power system in production K3

CO5: Select the appropriate automation technique for an application K3

UNIT – I PRIMARY MANUFACTURING OF HEAVY EQUIPMENT AND MATERIAL SELECTION 9

Process Plant Equipment

Introduction to Primary Manufacturing, Classification of Process Plant Equipment in various Industrial Sectors, Overview of typical process and Plant & Equipment Layout of Refinery, Petrochemical, Fertilizer, and Power Plant; Quality in Manufacturing, Brief overview of Quality control checks in the manufacturing industry

Selection of Material-

Mechanical and Thermal properties affecting the Design Process; Microstructure variations with alloying element; Effect of Processing Route on Material Properties; Selection of Material for specific Applications- Strength, Stiffness, deflection, Cost & energy; Use of Polymeric Composite in Industrial appliances

Casting Technology –

Introduction, Technology of mould and core making; Special sand molding processes; Design- Gating, Riser; Special casting, Overview of ASME codes for Casting

UNIT – II HEAVY METAL FORMING AND WELDING TERMINOLOGY 9

Heavy Forging - Forgeable Materials; Steel Melting and Ingot casting; Open and closed die forging; Forging temperature of different class of materials; Forging defects; Overview of ASME codes for Forgings Heavy Sheet metal forming – Surface development; Cylindrical shell forming; Conical Shell forming; Dished End forming; Bending process- Tube bending, Pipe bending, Plate bending; Welding terminology and Procedure qualification- Types of joint and symbol; Welding position; Base Metal, Filler Metal and Weld metal- classification (P, F, A numbering); Welding Procedure Specification (WPS) and Procedure Qualification Records (PQR); Welding Consumable Specifications; Welding defects and distortion analysis

UNIT – III WELDING PROCESS AND POST WELD TREATMENT 9

Welding Process - Shielded Metal Arc Welding (SMAW); Gas Tungsten Arc Welding (GTAW); Gas Metal Arc welding (GMAW); Flux Cored Arc Welding (FCAW); Submerged Arc Welding (SAW); Electro Slag Strip Cladding (ESW Strip Cladding); Submerged Arc Strip Cladding (SASC); Plasma Arc Welding; Laser Beam Welding; Electron beam welding; Resistance Welding Special type of Welding- Thermite Welding; Friction Stir Welding; Tandem Welding; Explosive Welding; Multi pass welding; Welding Parameters in quality Welds Post Weld treatment- Stress Relieving; Normalizing; Tempering; Types of furnace.

UNIT - IV MACHINING PROCESS AND FLUID POWER SYSTEM IN PRODUCTION 9

Machining - Mechanism of Material Removal; Tool wear and Tool life; Machining operations -Turning, Boring, Milling; Special Machining Process- Deep Hole Drilling, Gang Drilling, Jig Grinding, Jig Boring; Complex shape Machining - Thread machining, Thread Whirling; Special machining and Manufacturing- Shear Cutting; Water jet cutting; Plasma Arc Cutting; Laser Cutting; Shrink Fitting; Tube to T/S joint Expansion; Electro discharge machining; Machining of FRP and Ceramics Fluid power System in Production - Components of fluid power system; Fluid power generation; Control Valves; Industrial Application circuits- Tool and workpiece motion control; Hydraulic circuit for – Drilling head, Hydraulic press, clamping and forklifting circuit; Servo valves Application circuits; Pneumatic application circuits.

UNIT – V MANUFACTURING CYCLE, QUALITY CONTROL AND IOT IN WELDING 9

Manufacturing cycle for Pressure Vessel -Construction and Type of Service in Pressure vessel; Components in Pressure Vessel; Manufacturing lifecycle of Pressure vessel; Metal forming of petals; Metal Coating; Refractory coatings and painting; Quality Control - Design for Inspection; Non-destructive Inspection; Dimensional check; Destructive Testing

IOT in Welding – Industry 4.0, Automation in Welding- different technologies used for welding automation; Digitalization

TOTAL :45 PERIODS

TEXT BOOKS:

1. Fabrication of Metallic Pressure Vessels - Owen R. Greulich, Maan H. Jawad – Wiley Publisher-ASME Press, 2021.
2. Practical guide to Pressure vessel manufacturing – Sunil Pullarcot- Marcel Dekker Inc, CRC Press, 2002.

REFERENCE BOOKS:

1. An Introduction to Materials Engineering and Science for Chemical and Materials Engineers - Brian S. Mitchell – Wiley Publisher
2. Quality Control in Fabrication of Nuclear Pressure Vessels, Robert D. Wylie, Warren J. McGonnagle, 1964.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C208.1	3	-	-	-	-	-	-	-	-	-	-	1	1	1
C208.2	3	-	-	-	-	-	-	-	-	-	-	1	1	1
C208.3	3	-	-	-	-	-	-	-	-	-	-	1	1	1
C208.4	2	2	2	-	-	-	-	-	-	-	-	1	1	1
C208.5	3	2	2	-	-	-	-	-	-	-	-	1	1	1
C208	**2.80**	**2.00**	**1.00**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.00**	**1.00**	**1.00**

SEMESTER – IV

24BEME441 MANUFACTURING TECHNOLOGY 5H – 4C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Physics at 10+2 level or equivalent level

COURSE OBJECTIVES:

The goal of this course is for the students to

- To study the mechanics of metal cutting and the factors affecting machinability
- To learn the principles of various machining processes.
- To impart knowledge on Computer Numerical Control (CNC) of machine tools and CNC Programming

COURSE OUTCOMES:

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

CO1: Explain the mechanism of metal removal process and the factors involved in machining. K2

CO2: Make use of suitable machines for turning operations K3

CO3: Identify suitable machining process for fabricating a component K3

CO4: Outline the constructional features and working principles of CNC machine tools. K2

CO5: Explain the Program CNC machine tools through planning, writing codes and setting up CNC machine tools to manufacture a given component. K3

UNIT – I MECHANICS OF METAL CUTTING 9

Mechanics of chip formation, forces in machining, Types of chip, cutting tools – single point cutting tool nomenclature, orthogonal and oblique metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

UNIT – II TURNING MACHINES 9

Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, surface roughness in turning, machining time and power estimation. Special lathes - Capstan and turret lathes- tool layout – automatic lathes

UNIT – III RECIPROCATING MACHINE TOOLS 9

Reciprocating machine tools: shaper, planer, slotter: Types and operations- Hole making: Drilling, reaming, boring, tapping, type of milling operations-attachments- types of milling cutters– machining time calculation - Gear cutting, gear hobbing and gear shaping – gear finishing methods Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding - micro finishing methods

UNIT – IV CNC MACHINES 9

Computer Numerical Control (CNC) machine tools, constructional details, special features – Drives, Recirculating ball screws, tool changers; CNC Control systems – Open/closed, point-to-point/continuous - Turning and machining centres – Work holding methods in Turning and machining centres, Coolant systems, Safety features.

UNIT – V PROGRAMMING OF CNC MACHINE TOOLS 9

Coordinates, axis and motion, Absolute vs Incremental, Interpolators, Polar coordinates, Program planning, G and M codes, Manual part programming for CNC machining centers and Turning centers – Fixed cycles, Loops and subroutines, Setting up a CNC machine for machining.

TOTAL :45 PERIODS

LIST OF EXPERIMENTS: **30 PERIODS**

1. Machining operations in Centre lathe.
2. 'V' Block machining in Shaping machine.
3. Spur Gear cutting in Milling machine.
4. Drilling, Reaming and Tapping in Radial Drilling machine.
5. Polishing in Cylindrical Grinding machine.
6. Profile Turning programming in Mastercam and machining in CNC machine.
7. Profile Milling programming in Mastercam and machining in CNC machine.

TEXT BOOKS:

1. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India,7th Edition, 2018.
2. Michael Fitzpatrick, Machining and CNC Technology, McGraw-Hill Education; 4th edition, 2018.

REFERENCES:

1. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.
2. Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 1984.
3. Rao. P.N "Manufacturing Technology," Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi, 2009.
4. A. B. Chattopadhyay, Machining and Machine Tools, Wiley, 2nd edition, 2017.
5. Peter Smid, CNC Programming Handbook, Industrial Press Inc; Third edition, 2007.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C209.1	2	1	-	-	-	-	-	-	-	-	-	1	1	1
C209.2	3	2	1	-	-	-	-	-	-	-	-	1	1	1
C209.3	3	2	1	-	-	-	-	-	-	-	-	1	1	1
C209.4	2	1	-	-	-	-	-	-	-	-	-	1	1	1
C209.5	3	2	1	-	-	-	-	-	-	-	-	1	1	1
C209	**2.80**	**2.00**	**1.00**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.00**	**1.00**	**1.00**

SEMESTER – IV

24BEME442 THERMAL ENGINEERING 5H – 4C

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

End Semester Exam: 3 Hours

(Use of standard thermodynamic table, Steam Table and Mollier diagram are permitted in the examination)

PRE-REQUISITES: Engineering Thermodynamics

COURSE OBJECTIVES:

The goal of this course is for the students to

- To acquire knowledge on the thermodynamic concepts and laws related to engineering devices
- To learn the operation of IC engines, Air compressor and Cogeneration system
- To study the performance of IC engines and Air compressors

COURSE OUTCOMES:

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

CO1:	Apply the concepts of thermodynamics systems	K3
CO2:	Evaluate the properties of fuels	K3
CO3:	Utilize the various performance parameters of IC engines	K3
CO4:	Solve problems in single stage and multistage air compressors	K3
CO5:	Apply energy audit methods and waste heat recovery technologies	K3

UNIT I AIR STANDARD CYCLES 9

Air standard cycle assumptions – Otto, Diesel, Dual and Brayton cycles – Calculation of mean effective pressure and air standard efficiency – Comparison of Otto, Diesel, and Dual cycles – Actual and theoretical PV diagrams of four stroke and two stroke engines.

UNIT II PROPERTIES AND COMBUSTION OF FUELS 9

Properties and testing of fuels – Relative density – Calorific value – Distillation – Vapour pressure – Flash point – Spontaneous ignition temperature – Viscosity – Pour point – Flammability – API gravity – Aniline point – Octane number and Cetane number – Fuel requirements – Combustion of fuel – Air fuel ratio – Calculation of theoretical air requirement – Excess air calculation.

UNIT III PERFORMANCE ANALYSIS OF INTERNAL COMBUSTION ENGINES 9

Engine performance, parameters and characteristics – Variables affecting engine performance – Engine power – Mean effective pressure – Engine efficiencies – Specific fuel consumption – Heat balance sheet – Thermal analysis of Supercharger: Effects of supercharging – Thermodynamic analysis of supercharged engine cycle – Power input to mechanically driven supercharger – Turbo charging and charge cooling.

UNIT IV AIR COMPRESSORS 9

Classifications of compressors – Reciprocating air compressor – Performance characteristics – Effect of clearance volume – Free air delivery and displacement – Multistage air compressor – Rotary compressor – Vane type, centrifugal and axial flow – Layout of screw compressor – Energy efficiency opportunities in compressed air systems.

UNIT V ENERGY AUDITING AND WASTE HEAT RECOVERY 9

Need of Energy audit – Types of energy audit – Energy management (audit) approach – Understanding energy costs, benchmarking – Cogeneration cycles – Topping – Bottoming – Organic Rankine cycles – Steam turbine cogeneration systems – Gas turbine cogeneration systems – Reciprocating IC engines cogeneration systems – Combined cycles cogeneration systems – Waste heat recovery – Sources and Types – Selection criteria for waste heat recovery technologies – Recuperators – Regenerators – Economizers – Plate heat exchangers – Thermic fluid heaters – Waste heat boilers.

45 PERIODS

LIST OF EXPERIMENTS: 30 PERIODS

1. Determination of flash and fire points of petroleum products
2. Determination of viscosity of lubricating oil
3. Valve timing and port timing diagram
4. Heat balance test on IC Engine
5. Morse test on multi cylinder engine
6. Determination of performance characteristics of air compressor and air blowers
7. Determination of Economical speed for fixed load on four stroke Engine

TOTAL: 75 PERIODS

TEXTBOOKS:

1. Rajput R K, "Thermal Engineering", 10th Edition, Laxmi Publications, 2018.
2. Kothandaraman C P and Domkundwar A V, "A Course in Thermal Engineering", 5th Edition, Dhanpat Rai Publications, 2020.

REFERENCE BOOKS:

1. Ganesan V, "Internal Combustion Engines", 4th Edition, Tata McGraw Hill, 2017.
2. Yunus Cengel A, Robert Turner H and John Cimbala M, "Fundamentals of Thermal-Fluid Sciences", 5th Edition, Tata McGraw Hill, 2021.
3. Sarkar B K, "Thermal Engineering", 1st Edition, Tata McGraw Hill Publishers, 2017
4. Samir Sarkar, "Fuels and Combustion", 3rd Edition, Universities Press, 2020
5. Pundir B P, "Engine emissions – Fundamentals and advances in control", 2nd Edition, Alpha Science Publishers, 2017.

WEB URLs:

1. https://www.web.mit.edu/16.unified/www/FALL/thermodynamics/index.html
2. https://www.the-eye.eu/public/murdercube.com/Physics/A Guideto Cogeneration.pdf
3. https://www.beeindia.gov.in/sites/default/files/1Ch3.pdf

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C210.1	3	2	1	-	1		-	-	-	-	-	2	1	-
C210.2	3	2	1	-	1		-	-	-	-	-	2	1	-
C210.3	3	2	1	-	1		-	-	-	-	-	2	1	-
C210.4	3	2	1	-	1		-	-	-	-	-	2	1	-
C210.5	3	2	1	-	1		-	-	-	-	-	2	1	-
C210	**3**	**2**	**1**	**-**	**1**		**-**	**-**	**-**	**-**	**-**	**2**	**1.00**	**-**

SEMESTER – IV

24BEME443 STRENGTH OF MATERIALS 5H – 4C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Engineering Mechanics

COURSE OBJECTIVES:

The goal of this course is for the students to

- To acquire the knowledge on the types of stresses and strains induced on a body
- To study the shearing force, bending moment, slope and deflection in the beams
- To learn the mechanics of various simple structural members

COURSE OUTCOMES:

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

CO1:	Apply the fundamental concepts of stress and strains in simple and compound bars.	K3
CO2:	Construct the load transferring mechanism and stress distribution in beams	K3
CO3:	Calculate slope and deflection in beams using different methods.	K3
CO4:	Utilize the principal planes and stresses to design thin shells	K3
CO5:	Apply basic torsional equations to design circular shafts and helical springs.	K3

UNIT I SIMPLE STRESSES AND STRAINS 9

Rigid and deformable bodies – Assumptions – Saint Venant's principle – Principle of superposition method – Normal and shear stresses and strains – Stress strain diagram for brittle and ductile materials – Poisson's ratio – Lateral stress – Deformation of simple and compound bars – Relation between elastic constants –Thermal stresses – Strain energy in uniaxial loads – Gradually applied load, suddenly applied load and impact load.

UNIT II BEAMS – SHEAR FORCE, BENDING MOMENT AND STRESSES 9

Beams – Types and transverse loading on beams – Shear force and bending moment in beams – Cantilevers, simply supported and over hanging beam – Point of contra flexures.

Theory of simple bending – Assumptions – Derivation of bending equation – Neutral axis – Determination of bending stresses – Section modulus of rectangular and circular sections (Solid and Hollow), I, T and Channel sections – Shear stress distribution of simple beams – Circular, rectangular, I-section, T-section and channel sections.

UNIT III DEFLECTION OF BEAMS AND COLUMNS 9

Deflection of beams – Double integration method – Macaulay's method – Moment Area method – Columns – Theory of columns – Long column and short column – Euler's formula – Rankine's formula.

UNIT IV BI-AXIAL STRESS SYSTEM AND THIN CYLINDERS 9

Stress at point – Biaxial state of stress– Stresses on inclined planes – Principal planes and stresses – Mohr's circle for biaxial stress – Maximum shear stress – Thin cylinders and shells – Deformation in thin cylinders and spherical shells

UNIT V TORSION 9

Torsion of circular shaft – Shear stress distribution – Hollow and solid circular section –Stepped shaft – Twist and torsional stiffness – Compound shafts – Shafts fixed at both ends and simply supported – Torsion on springs – Wahl's factor of spring – Stiffness and deflection of springs under axial load.

45 PERIODS

LIST OF EXPERIMENTS:

1. Tension test on mild steel rod
2. Torsion test on mild steel rod
3. Impact test on metal specimen (Izod and Charpy test)
4. Hardness test on metals (Brinell and Rockwell hardness number)
5. Deflection test on cantilever beam and simply supported beam.
6. Tension test and Compression test on closed coiled helical spring

TEXT BOOKS:

1.Rajput R K, "A Textbook of Strength of Materials", 6th Edition, S Chand Publishing, 2018.
2. Rattan S S, "Strength of Materials", 3rd Edition, Tata McGraw Hill, 2017.

REFERENCE BOOKS:

1.Timoshenko S P and Gere M J, "Strength of Materials", 3rd Edition, CBS Publishers, 2021.
2.Ramamurtham S, "Strength of Materials", 20th Edition, Dhanpat Rai Publications, 2020.
3.Popov E P, "Engineering Mechanics of Solids", 2nd Edition, Pearson Education, 2018.
4.Hibbeler R C, "Mechanics of Materials", 10th Edition, Prentice Hall, 2022.
5. Beer F P, Johnston E R, DeWolf J T and Mazurek D F, "Mechanics of materials", 8th Edition, Mc Graw Hill, 2020.

WEB URLs:

1.https://www.nptel.iitm.ac.in/Aeronautical/Strength of Materials/course strength of materials.pdf
2.https://www.engineeringlibrary.org/reference/beam-columns-air-force-stress-manual
3.https://www.courses.iris.nitk.ac.in/pluginfile.php/358728/course/overviewfiles/ME113Torsion.pdf ?forcedownload=1

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C211.1	3	3	2	-	1	-	-	-	-	-	-	2	1	1
C211.2	3	3	2	-	1	-	-	-	-	-	-	2	1	1
C211.3	3	3	2	-	1	-	-	-	-	-	-	2	1	1
C211.4	3	3	2	-	1	-	-	-	-	-	-	2	1	1
C211.5	3	3	2	-	1	-	-	-	-	-	-	2	1	1
C211	**3**	**3**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1.00**	**1.00**

SEMESTER – IV

24BEME444 THEORY OF MACHINES 5H – 4C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Engineering Mechanics

COURSE OBJECTIVES:

The goal of this course is for the students to

- To study force–motion relationship in machine components and balancing of forces
- To study the basic concepts of toothed gearing and kinematics of gear trains
- To acquire knowledge on the friction and vibration in machine elements

COURSE OUTCOMES:

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

CO1:	determine the velocity and acceleration of mechanisms	K3
CO2:	Solve problems on gears and gear trains.	K3
CO3:	calculate friction in machine elements.	K3
CO4:	Determine the dynamic forces acting on machine components	K3
CO5:	Calculate the balancing masses and vibration in machine components	K3

UNIT – I KINEMATICS OF MECHANISMS 9

Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – kinematics analysis in simple mechanisms – velocity and acceleration polygons– Analytical methods – computer approach – cams – classifications – displacement diagrams - layout of plate cam profiles – derivatives of followers motion – circular arc and tangent cams.

UNIT – II GEARS AND GEAR TRAINS 9

Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains – automotive transmission gear trains.

UNIT – III FRICTION IN MACHINE ELEMENTS 9

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Bearings and lubrication – Friction clutches – Belt and rope drives – Friction aspects in brakes– Friction in vehicle propulsion and braking.

UNIT – IV FORCE ANALYSIS 9

Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Three and four members – Static Force analysis in simple machine members – Dynamic Force Analysis – Inertia Forces and Inertia Torque – D'Alembert's principle – superposition principle – dynamic Force Analysis in simple machine members.

UNIT – V BALANCING AND VIBRATION 9

Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines – free vibrations – Equations of motion – natural Frequency – Damped Vibration – bending critical speed of simple shaft – Torsional vibration – Forced vibration – harmonic Forcing – Vibration isolation. (Gyroscopic principles).

45 PERIODS

LIST OF EXPERIMENTS **30 PERIODS**

1. Determination of performance characteristics of Governor's.
2. Determination of profile of the cam and gyroscopic couple.
3. Determination of the critical speed of the shaft with concentrated loads.
4. Balancing of rotating and reciprocating masses.
5. Determination of moment of inertia by oscillation method for connecting rod and flywheel.
6. Determination of torsional frequencies and damping coefficient for various system
7. Determination of natural frequency and deflection of beam.

TOTAL: 75 PERIODS

TEXT BOOKS:

1. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 2017.
2. Ramamurthi. V, "Mechanics of Machines", Narosa Publishing House, 3rd edition 2019.

REFERENCES:

1. AmitabhaGhosh and Asok Kumar Mallik, "Theory of Mechanisms and Machines", Affiliated East-West Pvt. Ltd., 1988.
2. Rao.J.S. and Dukkipati.R.V. "Mechanism and Machine Theory", New Age International Pvt. Ltd., 2nd edition,2014.
3. Rattan, S.S, "Theory of Machines", McGraw-Hill Education Pvt. Ltd., 5th edition 2019.
4. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2013.
5. Wilson and Sadler, Kinematics and Dynamics of Machinery, Pearson, 2008.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C211.1	2	2	2	-	2	-	-	-	-	-	-	1	2	-
C211.2	3	2	2	-	2	-	-	-	-	-	-	1	2	-
C211.3	3	2	2	-	2	-	-	-	-	-	-	1	2	-
C211.4	3	2	2	-	2	-	-	-	-	-	-	1	2	-
C211.5	3	2	2	-	2	-	-	-	-	-	-	1	2	-
C211	**2.8**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	1	**2**	**-**

SEMESTER – IV

24BEME411	SKILL DEVELOPMENT – II NDE METHODS	2H – 1C

Instruction Hours/week: L:0 T:0 P:2 **Marks:** Internal**:100** External**:00** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The goal of this course is for students to

- To provide a basic understanding with case studies on different surface NDE techniques
- To apply them for inspecting materials in accordance with industry specifications and standards.

COURSE OUTCOMES

- Have a basic knowledge of surface NDE techniques which enables to carry out various inspection in accordance with the established procedures.
- Calibrate the instrument and inspect for in-service damage in the components.
- Differentiate various defect types and select the appropriate NDT methods for better evaluation

UNIT I Visual Testing and Liquid Penetrant Testing

Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods, penetrant testing – Interpretation and evaluation of test results - dye penetrant process, applicable codes and standards.

UNIT II Ultrasonic Inspection

Ultrasonic Inspection Methods and Equipment- Principle of pulse echo method, through transmission method, resonance method

UNIT III Magnetic Particle Testing and Eddy Current Testing

Signal to noise ratio – equipment's, reference samples, magnetic particle inspection of castings and welding – Dry continuous method, wet residual method

Assessment Methods: At the end of the training programme, the participants are required to appear for the examination consisting of theory as well as practical sessions.

SUGGESTED READINGS

1. C. Hellier, Handbook of NonDestructive Evluation, McGraw-Hill Professional, 1st edition (2001).
2. J. Thomas Schmidt, K. Skeie and P. Maclntire, ASNT Non Destructive Testing Handbook: Magnetic Particle Testing, American Society for Nondestructive Testing, American Society for Metals, 2nd edition (1989).
3. V. S. Cecco, G. V. Drunen and F. L. Sharp, Eddy current Manual: Test method, Vol.1, Chalk River Nuclear Laboratories (1983).
4. B.P.C. Rao, Practical Eddy Current Testing, Alpha Science International Limited (2006). 5. N. A. Tracy, P. O. Moore, Non-Destructive Testing Handbook: Liquid Penetrant Testing, Vol. 2, American Society for Nondestructive Testing, 3rd edition (1999).

SEMESTER – IV

24BEMC451 FOUNDATION OF ENTREPRENEURSHIP 1H – 0C

Instruction Hours/week: L:1 T:0 P:0 **Marks:** Internal**:100** External**:00 T**otal**:100**

End Semester Exam: 3 Hours

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

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.

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.

SEMESTER – IV

24BEMC452 ESSENCE OF TRADITIONAL INDIAN KNOWLEDGE AND HERITAGE 1H – 0C

Instruction Hours/week: L:1 T:0 P:0 **Marks:** Internal**:100** External**:00 T**otal**:100**

End Semester Exam: 3 Hours

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.

SEMESTER – V

24BEME501 DESIGN OF MACHINE ELEMENTS 4H – 4C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Strength of Materials

COURSE OBJECTIVES:

The goal of this course is for the students to

- To learn the various terminologies involved in design Process.
- To practice the various steps involved in design of machine elements
- To design machine elements using standards

COURSE OUTCOMES:

Upon completion of this course the students will be able to

CO1: Identify the stresses and deflections in machine members under loading conditions. K3

CO2: Design shafts and couplings to meet given requirements. K3

CO3: Design threaded and welded joints for the structures. K3

CO4: Make use of the design procedure to design springs and flywheels. K3

CO5: Select a bearing for a given application. K3

UNIT I STEADY STRESSES AND VARIABLE STRESSES IN MACHINE 9

Introduction to the design process – factors influencing machine design, selection of materials based on mechanical properties – Factor of safety. Direct, Bending, and torsional stress equations – Impact and shock loading – calculation of principal stresses for various load combinations, eccentric loading – Design of curved beams – crane hook and 'C' frame – theories of failure – stress concentration – design for variable loading – Soderberg, Goodman, and Gerber relations.

UNIT II DESIGN OF SHAFTS AND COUPLINGS 9

Design of solid and hollow shafts based on strength, rigidity, and critical speed – Design of keys and keyways, Design of rigid and flexible couplings – Introduction to gear and shock absorbing couplings – design of knucklejoints.

UNIT III DESIGN OF FASTENERS AND WELDED JOINTS 9

Threaded fasteners – Design of bolted joints including eccentric loading – Design of welded joints for pressurevessels and structures – theory of bonded joints.

UNIT IV DESIGN OF SPRINGS AND FLYWHEEL 9

Design of helical, leaf, disc, and torsional springs under constant loads and varying loads – Concentric torsion springs – Belleville springs – Design of flywheels involving stresses in rim and arm.

UNIT V DESIGN OF BEARINGS AND LEVERS 9

Selection of bearings – sliding contact and rolling contact types – Cubic mean load – Selection of journal bearings – McKee's equation – Lubrication in journal bearings – calculation of bearing dimensions – Design of Levers – Simple Levers.

(Permitted to use of PSG design data book in the examination)

TOTAL: 45+15 PERIODS

TEXTBOOKS:

1. Bhandari V.B, Design of Machine Elements, 4e, Tata McGraw–Hill Book Co, New Delhi, 2016
2. R S Khurmi and J. K. Gupta, A Textbook of Machine Design, 34th edition, S. Chand Publishing, 2019

REFERENCE BOOKS:

1. Juvinall R.C and Marshek K.M, Machine Component Design, 5th Edition, John Wiley and Sons, New Delhi, 2016
2. Spotts M.F, Design of Machine Elements, 8th edition, Pearson Education, New Delhi, 2019
3. Design Data: Data Book of Engineers by PSG College-Kalaikathir Achchagam – Coimbatore
4. V B Bhandari, Machine Design Data Book, 2nd Edition, Tata McGraw Hill Publishing Co, 2019.

WEBSITES:

1. https://www.me.iitb.ac.in/~ramesh/courses/ME423/shafts.pdf
2. https://web.itu.edu.tr/~halit/Makel/Ch_11_slides_m.pdf

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C301.1	3	2	1	-	-	-	-	-	-	1	-	2	1	-
C301.2	3	2	1	-	-	-	-	-	-	1	-	2	1	-
C301.3	3	2	1	-	-	-	-	-	-	1	-	2	1	-
C301.4	3	2	1	-	-	-	-	-	-	1	-	2	1	-
C301.5	3	2	1	-	-	-	-	-	-	1	-	2	1	-
C301	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1.00**	**-**	**2.00**	**1.00**	**-**

SEMESTER – V

24BEME541 HEAT AND MASS TRANSFER 5H – 4C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Thermodynamics

COURSE OBJECTIVES:

The goal of this course is for the students to

- To impart knowledge of various modes of heat transfer.
- To recognize the importance of heat exchangers.
- To study about the basic concepts of mass transfer.

COURSE OUTCOMES:

Upon completion of this course the students will be able to

CO1: Apply of conductive heat transfer equation to solve related problems. K3
CO2: Construct the heat transfer phenomenon of natural and forced convection. K3
CO3: Calculate the performance of heat exchangers. K3
CO4: Resolve the radiation related heat exchange problems K3
CO5: Estimate coefficient of mass transfer in convection. K3

UNIT I CONDUCTION 9

Basic Concepts – Mechanism of Heat Transfer – Conduction, Convection and Radiation – General Differential equation of Heat Conduction – Fourier Law of Conduction – Cartesian and Cylindrical Coordinates – One Dimensional Steady State Heat Conduction – Conduction through Plane Wall, Cylinders and Spherical systems – Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Use of Heisler's Chart.

UNIT II CONVECTION 9

Basic Concepts – Convective Heat Transfer Coefficients – Boundary Layer Concept – Types of Convection – Forced Convection –External Flow – Flow over Plates, Cylinders and Spheres – Internal Flow – Laminar and Turbulent Flow – Combined Laminar and Turbulent – Flow over Bank of tubes – Free Convection –Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres.

UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 9

Nusselt's theory of condensation–pool boiling, flow boiling, correlations in boiling and condensation. Types of Heat Exchangers – LMTD Method of heat Exchanger Analysis – Effectiveness – NTU method of Heat Exchanger Analysis – Overall Heat Transfer Coefficient – Fouling Factors.

UNIT IV RADIATION 9

Basic Concepts, Laws of Radiation – Stefan Boltzmann Law, Kirchoff Law –Black Body Radiation – Grey body radiation - Shape Factor Algebra – Electrical Analogy – Radiation Shields – Introduction to Gas Radiation.

UNIT V MASS TRANSFER 9

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations

(Permitted to use standard Heat and Mass Transfer Table in the examination)

45 PERIODS

LIST OF EXPERIMENTS: 30 PERIODS

1. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
2. Determination of thermal conductivity of insulating powder, composite wall.
3. Determination of heat transfer coefficient under natural and forced convection
4. Heat transfer from pin-fin apparatus by using natural and forced convection modes.
5. Determination of Stefan– Boltzmann constant.
6. Determination of emissivity of a grey surface.
7. Determination of Coefficient of Performance of a vapour compression refrigeration system.

TOTAL: 75 PERIODS

TEXTBOOKS:

1. Sachdeva R.C, Fundamentals of Engineering Heat and Mass Transfer, 4thedition, New Age International, New Delhi,2017.
2. Frank P. Incropera and David P. DeWitt, Fundamentals of Heat and Mass Transfer, 7thedition, John Wiley and Sons,New Delhi, 2011.

REFERENCE BOOK:

1. Jack P. Holman, Heat Transfer, 10thedition, McGraw–Hill Book Co, New Delhi, 2017.
2. Kothandaraman C.P, Fundamentals of Heat and Mass Transfer, 4th Edition, New Age International, New Delhi, 2015.

WEB URLs.:

1. https://www.techscience.com/journal/fhmt
2. https://www.thermalfluidscentral.org/journals/index.php/Heat_Mass_Transfer

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C302.1	3	2	1	-	-	-	-	-	-	1	-	2	1	-
C302.2	3	3	3	2	-	-	-	-	-	1	-	2	1	-
C302.3	3	3	3	2	-	-	-	-	-	1	-	2	1	-
C302.4	3	2	1	-	-	-	-	-	-	1	-	2	1	-
C302.5	3	2	1	-	-	-	-	-	-	1	-	2	1	-
C302	**3.0**	**2.40**	**1.8**	**2.00**	**-**	**-**	**-**	**-**	**-**	**1.00**	**-**	**2.00**	**1.00**	**-**

SEMESTER – V

24BEME542 METROLOGY AND MEASUREMENTS 5H – 4C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Physics at 10+2 level or equivalent level

COURSE OBJECTIVES:

- To learn the general concepts involved in measurements.
- To acquire knowledge on the various metrological equipment's
- To learn the procedures for measuring the components

COURSE OUTCOMES:

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

CO1: Explain the basic principles of measurements and its significance K2
CO2: Demonstrate linear and angular measurement tools for measuring the components K3
CO3: Apply the procedure of form measurements in engineering applications K3
CO4: make use of the advanced measuring equipment's for suitable applications K3
CO5: Explain the principles of digital and thermal measuring equipment's K2

UNIT I BASICS OF METROLOGY 9

General concept of measurement system – Units and standards – Definition of metrology – Measuring instruments – Sensitivity – Range of accuracy – Accuracy versus Precision – Repeatability, readability and reproducibility – Static and dynamic response in measurements – Uncertainty and its importance – Errors – Systematic and random errors – Correction– Correction factor – Calibration – Introduction to dimensional and geometric tolerance– Concept of interchangeability and selective assembly.

UNIT II LINEAR AND ANGULAR MEASUREMENTS 9

Linear measuring instruments: Vernier caliper, Vernier height gauge, Vernier depth gauge, micrometer – Internal measurement – Slip gauges and classification – Applications – Basics of interferometry – Optical flats – Limit gauges – Types – Taylor's principle of gauge design – Comparators: Mechanical, optical, pneumatic, electrical and electronic types – Applications – Angular measurements: sine bar, bevel protractors – Taper measurement concepts – Applications – Autocollimator and angle dekkor – Applications

UNIT III FORM MEASUREMENTS 9

Measurement of screw threads – Terminology – Effective diameter – Measurement of gears – Terminology – Tooth thickness – Gear tooth Vernier caliper – Profile projectors –Surface finish measurements – Straightness, flatness and roundness measurements.

UNIT IV ADVANCES IN METROLOGY 9

Precision instruments based on laser – Principles – Laser interferometers – Applications in linear, angular measurement and machine tool metrology – Coordinate Measuring Machine (CMM) – Constructional features – Types – Applications – Digital devices – Computer aided inspection – Machine vision systems – Force, torque, power measurements: Mechanical, pneumatic, hydraulic and electrical type

UNIT V DIGITAL AND THERMAL METROLOGY 9

Acoustics – Ultrasonic − Radiation thermal and capacitance-based measurement − Temperature measurements: Bimetallic strip, pressure thermometers, thermocouple, electrical resistance thermistor – – Vibrometers and accelerometers – Seismic accelerometers.

45 PERIODS

LIST OF EXPERIMENTS:

1. Checking linear dimensions of a part using Vernier caliper and micrometer.
2. Measurement of taper angle using sine bar and bevel protractor.
3. Measurement of cutting tool parameters using tool maker's microscope.
4. Checking the limits of dimensional tolerances using mechanical comparator.
5. Measurement of temperature using thermocouple.
6. Measurement of displacement using LVDT.
7. Measurement of gear tooth thickness using gear tooth vernier.

TOTAL: 75 PERIODS

TEXT BOOKS:

1. Jain R K, Engineering Metrology, Khanna Publishers Twentieth Edition , 2017.
2. Thomas G Beckwith,Roy D Marangoni and John H Lienhard V, Mechanical Measurements, Pearson, Sixth Edition, 2018.

REFERENCE BOOKS:

1. Alan S Morris, The Essence of Measurement, Prentice Hall of India,Fourth Edition, 2007.
2. Gupta I C, Engineering Metrology, Khanna Publishers, Tenth Edition, 2018.
3. Dotson C,Harlow R and Thompson R L, Fundamentals of Dimensional Metrology, Cengage Learning, Fourth Edition, 2005.
4. Jayal A K, Instrumentation and Mechanical Measurements, Galgotia Publications,
5. Eighth Edition , 2010 .
6. Donald P Eckman , Industrial Instrumentation, CBS Publishers and Distributors, First Edition, 2004 .

WEB URLs:

1. www.cosmolearning.org/courses/mechanical-measurements-and-metrology/
2. www.mechanical.in/engineering-metrology-and-measurements-subject-notes/
3. www.roton.com/identify_threads.aspx
4. www.faadooengineers.com/threads/26831-Mechanical-metrology-and-measurements-iit-notes-ebook-download-rar
5. www.nptel.ac.in/courses/112106139/pdf/4_1.pdf

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C303.1	3	2	1	-	1	-	-	-	1	-	-	1	1	-
C303.2	3	2	1	-	1	-	-	-	1	-	-	1	1	-
C303.3	3	2	1	-	1	-	-	-	1	-	-	1	1	-
C303.4	3	2	1	-	1	-	-	-	1	-	-	1	1	-
C303.5	3	2	1	-	1	-	-	-	1	-	-	1	1	-
C303	**3**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**1**	**-**

SEMESTER – V

24BEME5E01 PE – I, DIGITAL TECHNOLOGIES WITH CPS, IIOT AND CLOUD IN MANUFACTURING 3H – 3C

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

End Semester Exam: 3 Hours

SEMESTER – V

24BEME5E02 PE – II, COGNITIVE MANUFACTURING – AI AND MACHINE VISION 3H – 3C

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

End Semester Exam: 3 Hours

SEMESTER – V

24BEME5E03 PROFESSIONAL ELECTIVE – III 3H – 3C

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

End Semester Exam: 3 Hours

SEMESTER – V

24BEME5OE01 OPEN ELECTIVE – I 3H – 3C

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

End Semester Exam: 3 Hours

SEMESTER – V

24BEME511 COMPUTER AIDED MODELING LAB 4H – 2C

Instruction Hours/week: L:0 T:0 P:4 **Marks:** Internal**:40** External**:60 T**otal**:100**

End Semester Exam: 3 Hours

PRE-REQUISITES: Graphics, Geometric Tolerances and Drawing in Manufacturing

COURSE OBJECTIVES:

- To expose on 3D Modelling and Assembling musing software's.
- To impart practical knowledge on surface Modelling and Assembling.
- To develop Sheet Metal Modelling for components.

OUTCOMES:

CO1: To draw orthographic projections of simple components using geometric modelling software **K3**

CO2: To develop three-dimensional model of simple mechanism using CAD software **K3**

CO3: To create three-dimensional assembly models of automotive components **K3**

CO4: To generate 3D assembly models of machine elements using CAD software **K3**

CO5: To create surface modelling for engineering components. **K3**

LIST OF EXPERIMENTS:

1. Study of CAD package capabilities.
2. 2D Drafting of Protected Flange Coupling.
3. 3D Modelling and Assembling of Gib and Cotter Joint.
4. 3D Modelling and Assembling of Screw Jack.
5. 3D Modelling and Assembling of Lathe Tail Stock.
6. 3D Modelling and Assembling of Die Block.
7. 3D Modelling, Assembling and Animation of Double Cylinder Engine.
8. 3D Modelling, Assembling and Animation of Gyroscope.
9. Surface modelling of the turbine blades with rotor.
10. Creation of a sheet metal component.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C308.1	3	2	1	-	1	-	-	-	-	1	-	1	1	-
C308.2	3	2	1	-	1	-	-	-	-	1	-	1	1	-
C308.3	3	2	1	-	1	-	-	-	-	1	-	1	1	-
C308.4	3	2	1	-	1	-	-	-	-	1	-	1	1	-
C308.5	3	2	1	-	1	-	-	-	-	1	-	1	1	-
C308	**3**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**-**

SEMESTER – V

24BEMC551 COMMUNITY ENGAGEMENT AND SOCIAL RESPONSIBILITY 3H – 2C

Instruction Hours/week: L:1 T:0 P:2 **Marks:** Internal**:100** External**:00 T**otal**: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)

SEMESTER – V

24BEMC552 CYBER SECURITY 1H – 0C

Instruction Hours/week: L:1 T:0 P:0 **Marks:** Internal**:100** External**:00 T**otal**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for students:

- To understand the field of digital security and concepts of access control mechanism.
- To introduce keywords and jargons involved in securing browser
- To understand network basic and familiarize on security of network protocols
- To understand cyber-attacks and data privacy
- To learn the tools and methods used in cyber security

COURSE OUTCOMES:

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

- Infer the importance of a network basics and brief introduction on security of network protocols.
- Apply a solid foundation in digital security and measures taken to protect device from threats.
- Discuss about cyber-attacks and data privacy issues and preventive measures.
- Make use of tools and methods used in cyber security.
- Explain Cyber security organizational implications.

UNIT I NETWORKING BASICS 9

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 9

Basics of digital security, protecting personal computers and devices, protecting devices from Virus and Malware, Identity, Authentication and Authorization, need for strong credentials, keeping credentials secure, protecting servers using physical and logical security, World Wide Web (www), the Internet and the HTTP protocol, security of browser to web server interaction

UNIT III INTRODUCTION TO CYBER-ATTACKS 9

Introduction to cyber-attacks, application security (design, development and testing), operations security, monitoring, identifying threats and remediating them, Principles of data security - Confidentiality, Integrity and Availability, Data Privacy, Data breaches, preventing attacks and breaches with security controls, Compliance standards, Computer Ethics.

UNIT IV TOOLS AND METHODS 9

Tools and methods used in cyber security: Proxy servers and anonymizers – Phishing – Password cracking – Keyloggers and spywares – Virus and worms – Trojan horse – Stegnography – DoS and DDoS attack – SQL Injection – Buffer overflow – Attacks on wireless networks – Phishing and Identity theft.

UNIT V CYBER SECURITY ORGANIZATIONAL IMPLICATIONS 9

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.

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.

REFERENCES 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

WEBSITES:

1. https://www.cybersecurityservices.com/
2. https://www.nist.gov/cybersecurity

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C310.1	3	3	2	2	-	2	-	-	-	-	-	2	2	2
C310.2	3	2	2	2	-	2	-	-	-	-	-	2	2	2
C310.3	3	3	2	2	-	2	-	-	-	-	-	2	2	2
C310.4	3	3	2	2	-	2	-	-	-	-	-	2	2	2
C310.5	3	2	2	2	-	2	-	-	-	-	-	2	2	2
C310	**3**	**2.6**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**

SEMESTER – VI

24BEME601 DESIGN OF TRANSMISSION SYSTEMS 4H – 4C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Strength of Materials and Design of Machine Elements

COURSE OBJECTIVES:

The goal of this course is for students:

- To learn the various components of a transmission system and their standards
- To study the procedure involved in designing gears.
- To learn the design principles of clutches and brakes.

COURSE OUTCOMES:

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

CO1:	Design flexible elements like belts, chains and rope drives.	K3
CO2:	Solve problems on design to spur and helical gears.	K3
CO3:	Make use of design standards to design worm and bevel gears.	K3
CO4:	Apply the procedures to design gear boxes.	K3
CO5:	Solve problems on design of cams, brakes and clutches	K3

UNIT I DESIGN OF FLEXIBLE ELEMENTS 9

Selection of flat belts and pulleys – Selection of V belts and pulleys – Toothed belts – Materials used for belt drives – Selection of hoisting wire ropes and pulleys – Materials used for wire ropes – Selection of transmission chains and sprockets.

UNIT II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 9

Gear materials – Module and power rating calculations based on strength and wear considerations – Parallel axis helical gears – Pressure angle in normal and transverse plane – Equivalent number of teeth – Estimating the size of a pair of parallel axis helical gears

UNIT III BEVEL, WORM AND BALL SCREWS 9

Straight bevel gear – Tooth terminology –Equivalent number of teeth – Estimating the dimensions of pair of straight bevel gears – Worm gear – Terminology – Thermal capacity – Materials – Estimating the size of the worm gear pair – Design of power screws – Theory of Ball Screws – Selection of ball screws for CNC Machines.

UNIT IV GEAR BOXES 9

Requirements to obtain optimum design – Geometric progression – Standard step ratio – Ray diagram – Kinematics layout – Design of sliding mesh gear box – Constant mesh gear box – Design of multi speed gear box

UNIT V CLUTCHES AND BRAKES 9

Clutches – Axial clutches – Cone clutches – Internal expanding rim clutches – Brakes – Types of brakes – Self energizing and de-energizing brakes – Design of internally expanding shoe brakes – Calculation of heat generation and heat dissipation in brakes.

TOTAL: 45+15 PERIODS

(Use of PSG Design data book is permitted)

TEXT BOOKS:

1. Bhandari V B, Design of Machine Elements, Tata Mc Graw Hill, Fourth Edition, 2017.
2. Shigley J E and Mischke C R, Mechanical Engineering Design, Mc Graw Hill, Tenth Edition, 2011.

REFERENCE BOOKS:

1. Juvinall R C and Marshek K M, Fundamentals of Machine Component Design, John Wiley and Sons, Sixth Edition, 2017.
2. Prabhu T J, Design of Transmission Elements, T J Prabhu Publisher, First Edition, 2015.
3. Sundrarajamoorthy T V and Shanmugam N, Machine Design, Anuradha Publishing, Ninth Edition, 2014 .
4. Hamrock B J, Jacobson B and Schmid S R, Fundamentals of Machine Elements, CRC Press, Third edition, 2013.
5. Maitra G M and Prasad L V, Hand book of Mechanical Design, Tata McGraw–Hill, Second Edition, 2011.

WEB URLs:

1. www.nptel.ac.in/courses/IIT-MADRAS/Machine_Design_II/pdf/2_11.pdf
2. www.readorrefer.in/article/Selection-of-V-belts-and-pulleys_5917/
3. www.sites.google.com/site/designoftransmissionsystems/Design-of-Gear-Boxes
4. www.nptel.ac.in/courses/112106137/pdf/2_17.pdf
5. www.kinindia.com/university/design– of– transmission– systems– notes– me2352/

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C311.1	3	2	1	-	-	2	-	-	-	-	-	2	1	-
C311.2	3	2	1	-	-	2	-	-	-	-	-	2	1	-
C311.3	3	2	1	-	-	2	-	-	-	-	-	2	1	-
C311.4	3	2	1	-	-	2	-	-	-	-	-	2	1	-
C311.5	3	2	1	-	-	2	-	-	-	-	-	2	1	-
C311	**3**	**2**	**1**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**

SEMESTER – VI

24BEME602 RENEWABLE ENERGY SOURCES 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Thermal Engineering

COURSE OBJECTIVES:

The goal of this course is for students:

- To understand the renewal energy harvesting methods and their environmental impacts.
- To provide knowledge on energy production from different renewable energy sources.
- To enlighten the basic knowledge on energy economics and management.

COURSE OUTCOMES:

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

CO1: explain the statistics on availability of renewable energy source K2
CO2: recognize the techniques behind harvesting solar and wind energy K3
CO3: identify the procedures for harvesting energy from bio mass, tide and geo thermal source K3
CO4: classify modern energy harvesting methods K2
CO5: perform energy auditing and economics K2

UNIT I ENERGY AND ENVIRONMENT 9

Primary energy sources – World energy resources – Indian energy scenario – Energy cycle of the earth –Environmental aspects of energy utilization, CO_2 emissions and global warming – Renewable energy resources and their importance – Potential impacts of harnessing the different renewable energy resources.

UNIT II SOLAR AND WIND ENERGY 9

Principles of solar energy collection – Solar radiation – Measurements – Instruments – Types of collectors – Characteristics of different type of collectors – Performance of collectors – Solar thermal applications – Solar cooling – Solar drying – Solar ponds – Solar tower concept – Solar furnace. Energy from the wind – General theory of windmills – Types of windmills – Design aspects of horizontal axis windmills – Applications

UNIT III BIO ENERGY, TIDAL AND GEO THERMAL ENERGY 9

Energy from bio mass and bio gas plants – Various types – Design principles of bio gas plants – Applications – Energy from wastes – Waste burning power plants – Utilization of industrial and municipal wastes – Energy from the agricultural wastes. Energy from tides and waves – Working principles of tidal plants and ocean thermal energy conversion plants – Power from geothermal energy – Principle of working of geothermal power plants.

UNIT IV OTHER RENEWABLE ENERGY SOURCES 9

Direct energy conversion (Description, principle of working and basic design aspects only) – Magneto hydrodynamic systems (MHD) – Thermoelectric generators – Thermionic generators – Fuel cells – Solar cells – Types, EMF generated, power output, losses, efficiency, and applications – Hydrogen conversion and storage systems.

UNIT V ENERGY MANAGEMENT AND ECONOMICS 9

Energy auditing – Methodology – Analysis – Energy accounting – Measurements, Energy resource management – Energy management information systems – Computerized energy management – Energy economics – Discount rate, payback period, internal rate of return, life cycle costing – Financing energy conservation projects.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. John Twidell Tony Weir Renewable Energy Resources Routledge; Fourth Edition 2021.
2. S. C. Bhatia, R. K. Gupta Renewable Energy, Woodhead Publishing India PVT. Limited, 2019

REFERENCE BOOKS:

1. Kothari, D. P.Ranjan Rakesh Singal, K. C. Renewable Energy Sources And Emerging Technologies PHI Learning, Third Edition2022
2. Renewable Energy: Power for a Sustainable Future" by Godfrey Boyle, Bob Everett, and Janet Ramage, edition: 4th Edition,2019
3. Khan BH Non-Conventional Energy Resources Tata McGraw Hill, Third Edition2017.
4. Barney L Capehart Wayne C Turner William J Kennedy Guide to Energy Management the Fairmont Press Inc 2016
5. Mehmet Kanoğlu,Yunus A. Çengel, John M. Cimbala, Fundamentals and Applications of Renewable Energy, 1st Edition, 2020.

WEB URLs:

1. http://www.fi.edu/peco/solar-guide.pdf
2. http://earthsci.org/mineral/energy/wind/wind.html
3. http://education.nationalgeographic.com/education/encyclopedia/biomass-energy/?ar_a=1

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C312.1	2	1	-	-	-	2	-	-	-	-	1	1	1	-
C312.2	2	1	-	-	-	2	-	-	-	-	1	1	1	-
C312.3	2	1	-	-	-	2	-	-	-	-	1	1	1	-
C312.4	2	1	-	-	-	2	-	-	-	-	1	1	1	-
C312.5	2	1	-	-	-	2	-	-	-	-	1	1	1	-
C312	**2**	**1**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**-**

SEMESTER – VI

24BEME603 MECHATRONICS 4H – 4C

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

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for students:

- To acquire knowledge about the various types of sensors and transducers
- To learn various actuators and other components in a mechatronics system
- To apply mechatronics system for suitable applications

COURSE OUTCOMES:

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

CO1:	illustrate the types of sensors to construct a mechatronics system	K2
CO2:	infer the various drives and actuators in mechatronics design	K2
CO3:	Design mechatronics circuits for the given applications	K3
CO4:	Design a mechatronics system using PLC	K3
CO5:	apply the concept of mechatronics in real-world problems	K3

UNIT I SENSORS AND TRANSDUCERS 9

Introduction to Mechatronics system – Key elements – Mechatronics system design process – Types of design – Comparison between traditional and mechatronics approach – Sensors and transducers – Classification – Performance terminology – Displacement, position and proximity, torque, velocity, motion, force, fluid pressure, liquid flow, liquid level, temperature, light sensor – Selection of sensors.

UNIT II DRIVES AND ACTUATORS 9

Drives and actuators: Hydraulic and Pneumatic drives – Electrical actuators – Servo motor and Stepper motor – Drive circuits – Open and closed loop control – Embedded systems: Hardware structure – Software design and communication – Automatic control and real time control systems-

UNIT – III CIRCUITS AND SYSTEMS 9

Accumulators, Intensifiers, Industrial circuits – Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Deceleration circuits, Sizing of hydraulic/ Pneumatic systems, Hydrostatic transmission, Electro hydraulic/Pneumatic circuits, –Servo and Proportional valves – Applications- Mechanical, Hydraulic/Pneumatic servo systems.

UNIT IV PROGRAMMABLE LOGIC CONTROLLER 9

Introduction – Architecture – Input / Output processing – Programming with Timers, Counters and Internal relays –Data Handling – Selection of PLC.

UNIT V CASE STUDIES 9

Drone actuation and control – Autonomous Robot with vision system – Automotive mechatronics – Electronic ignition system – Adaptive cruise control. – Pick and Place robot – Engine management system – Automatic car park barrier.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1. Design of pneumatic circuits with manually operated valves.
2. Design of pneumatic circuits with logic sequence using electro pneumatic trainer kits.
3. Simulation of basic hydraulic, pneumatic and electric circuits using automation studio.
4. Design of pneumatic circuits so as to control its operation using PLC.
5. Servo motor / stepper motor controller for interfacing mechatronics system.
6. Simulate the speed control of an exhaust fan using LabVIEW.
7. Real time data acquisition system for monitoring temperature circuits with LabVIEW.

TEXT BOOKS:

1. Bolton W, "Mechatronics – Electronic Control Systems in Mechanical and Electrical Engineering", 7th Edition, Pearson, 2023.
2. Clarence W De Silva, "Mechatronics: A Foundation Course", 1st Edition, CRC press, 2010.

REFERENCE BOOKS:

1. Clarence W de Silva, Farbod Khoshnoud, Maoqing Li and Saman K. Halgamuge, "Mechatronics: Fundamentals and Applications", 1st Edition, CRC press, 2018.
2. Robert H Bishop, "Mechatronic Systems. Sensors and Actuators: Fundamentals and Modeling", 2nd Edition, CRC Press, 2018.
3. Biswanath Samanta "Introduction to Mechatronics: An Integrated Approach", 1st Edition, Springer, 2023.
4. Sabri Cetinkunt, "Mechatronics with Experiments," 2nd Edition, Wiley, 2018.
5. Robert H Bishop, "Mechatronics – An Introduction," 1st Edition, CRC Press, 2019.

WEB URLs:

1. https://www.web.itu.edu.tr/yalcinme/files/courses/MMG/ch1%20introduction%20to%20mechatronics.pdf
2. https://www.elprocus.com/understanding-a-programming-logic-controller/
3. https://www.msplpune.com/case-studies/

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C313.1	2	1	-	-	-	-	-	-	-	-	-	1	1	-
C313.2	2	1	-	-	-	-	-	-	-	-	-	1	1	-
C313.3	2	2	1	-	2	-	-	-	-	-	-	1	1	-
C313.4	3	2	1	-	2	-	-	-	-	-	-	1	1	-
C313.5	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C313	**2.4**	**1.4**	**1**	**-**	**2**	**-**	-	-	-	-	-	1	1	-

SEMESTER – VI

24BEME641 FINITE ELEMENT METHOD 5H – 4C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Strength of Materials and Heat and Mass Transfer

COURSE OBJECTIVES:

The goal of this course is for students:

- To learn the concepts of finite element method.
- To gain knowledge of numerical calculations and computer tools.
- To iimpart knowledge on heat transfer and fluid flow analysis problems.

COURSE OUTCOMES:

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

CO1: explain the basic concepts and importance of finite element methods. K2

CO2: Apply the finite element methods in one dimensional problems (Analyze) K4

CO3: Develop the finite element equations for two dimensional scalar problems K4

CO4: Make use of numerical analysis to solve problems in isoparametric elements K4

CO5: Solve problems in heat transfer using finite element methods K3

UNIT I INTRODUCTION 9

Introduction – Brief history of FEM – Applications of FEM in various fields, advantages, disadvantages and limitations of FEM – Convergence requirements – Introduction to different approaches used in FEA such as variational approach – Weighted residual method principle of minimum potential energy approach – Galerkin method, Raleigh-Ritz method and Gaussian elimination method.

UNIT II ONE-DIMENSIONAL PROBLEMS 9

General FEM procedure – Types of 1D elements – Displacement function by direct approach – Global, local and natural coordinate systems – Order of element – Shape functions – Assembly of global stiffness matrix – Formulation of elemental stiffness matrix and load vector for spring, rod, bar, beam and truss elements – Stress equilibrium equations – Strain-Displacement equations – Strain energy – Boundary conditions – Pascal's triangle, primary and secondary variables.

UNIT III TWO-DIMENSIONAL SCALAR VARIABLE PROBLEMS 9

Types of 2D elements – Formulation of stiffness matrix and load vectors for plane stress and plane strain elements – Axis symmetric problems such as Constant Strain Triangles (CST) and Linear Strain Rectangle (LSR).

UNIT IV ISOPARAMETRIC FORMULATION 9

Concept of isoparametric elements, super-parametric and sub-parametric elements – Isoparametric formulation of bar element – Area coordinates (for triangular elements), higher order elements – Jacobian matrix – Numerical integration – 2 and 3 point Gauss quadrature – Applications to cylinders under internal or external pressures.

UNIT V APPLICATIONS 9

One dimensional heat transfer element – Governing differential equation, steady-state heat transfer formulation of 1D element for conduction and convection problem – Applications to 2D heat transfer problems – General dynamic equation of motion – Numerical technique to dynamic problems, Eigen value problems – Application to fluid flow problems.

TOTAL: 45+15 PERIODS

LIST OF EXPERIMENTS:

1. Static structural analysis of cantilever beam and simply supported beam using various load.
2. Modal analysis for cantilever beam, fixed beam and simply supported beam.
3. Determine the temperature distribution and heat flux of a given plate with hole.
4. Determine the internal and external pressure distribution of a given hollow cylinder through axis symmetry approach.
5. Determine the temperature distribution of a given bend pipe using ANSYS Fluent.
6. Determine the fluid flow simulation of a given pipe of varying cross section.

TEXT BOOKS:

1. Daryl L Logan, A First Course in the Finite Element Method, CL Engineering, Sixth Edition, 2016.
2. Chandrupatla T R and BelegundaA D, Introduction to Finite Elements in Engineering, Prentice Hall of India, Fourth Edition, 2012.

REFERENCE BOOKS:

1. Seshu P, Text Book of Finite Element Analysis, Prentice Hall India, First Edition, 2012.
2. Bhatti Asghar M, Fundamental Finite Element Analysis and Applications, John Wiley and Sons, First Edition, 2013.
3. David V Hutton, Fundamental of Finite Element Analysis, Mc Graw Hill, First Edition, 2009.
4. Cook R D, Concepts and Applications of Finite Element Analysis, John Wiley and Sons, Fourth Edition, 2001.
5. Rao S S, The Finite Element Method in Engineering, Butterworth Heinemann, Fourth Edition, 2011.

WEB URLs:

1. www.elsevier.com/journals/finite-elements-in-analysis-and.../0168-874X
2. www.nptel.ac.in/courses/112104116/
3. www.engr.uvic.ca/~mech410/lectures/FEA_Theory.pdf
4. www.journals.elsevier.com/finite-elements-in-analysis-and-design
5. www.ocw.mit.edu/.../2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2014

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C314.1	2	2	2	-	2	-	-	-	-	-	3	1	1	-
C314.2	3	2	2	-	3	-	-	-	-	-	3	1	1	-
C314.3	3	2	2	-	3	-	-	-	-	-	3	1	1	-
C314.4	3	2	2	-	3	-	-	-	-	-	3	1	1	-
C314.5	3	2	2	-	3	-	-	-	-	-	3	1	1	-
C314	**2.8**	**2**	**2**	**-**	**2.8**	**-**	**-**	**-**	**-**	**-**	**3.0**	**1**	**1**	**-**

SEMESTER – VI

24BEME6E01	**PE – IV, COLLABORATIVE ROBOTIC IN MANUFACTURING WITH AI, ML, IIOT**	**3H – 3C**

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

End Semester Exam: 3 Hours

SEMESTER – VI

24BEME6E02	**PE – V, ADDITIVE MANUFACTURING**	**3H – 3C**

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

End Semester Exam: 3 Hours

SEMESTER – VI

24BEME6OE02	**OPEN ELECTIVE – II**	**3H – 3C**

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

End Semester Exam: 3 Hours

SEMESTER – VI

24BEME691 **MINI PROJECT** **4H – 2C**

Instruction Hours/week: L:0 T:0 P:4 **Marks:** Internal**:40** External**:60 T**otal**:100**

End Semester Exam: 3 Hours

PRE-REQUISITES: Core courses

COURSE OBJECTIVES:

The goal of this course is for students:

- To apply the engineering knowledge to obtain solutions for real-world problems.
- To explore the various solutions and propose the best solution based on findings.
- Develop skills in product development and project management

COURSE OUTCOMES:

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

CO1: conduct appropriate surveys and identify a product to be developed for the society K5

CO2: Design, develop, analyse the product using engineering principles as per the engineering standards K5

CO3: Manage the project with budget analysis K4

CO4: Communicate via oral communication, project report, presentation, demonstration K3

CO5: Perform in the team and contribute for the project K3

COURSE DESCRIPTION:

The students in a group has to identify a problem and find suitable solution and develop a prototype. Has to prepare a comprehensive project report and submit the report and present bebore the committee for evaluation.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C314.1	3	3	3	3	3	-	-	3	-	-	-	-	3	3
C314.2	3	3	3	3	3	3	3	3	-	-	-	-	3	3
C314.3	-	-	-	-	-	-	-	3	-	-	3	3	-	-
C314.4	-	-	-	-	-	-	-	3	-	3	3	3	-	-
C314.5	-	-	-	-	-	-	-	3	3	-	3	3	-	-
C314	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

SEMESTER – VI

24BEME651 UNIVERSAL HUMAN VALUES 1H – 0C

Instruction Hours/week: L:1 T:0 P:0 **Marks:** Internal**:100** External**:00 T**otal**:100**

End Semester Exam: 3 Hours

PRE-REQUISITE: NIL

COURSE OBJECTIVES:

The goal of this course for students is

- To help students to understand the need, basic guidelines, content and process of value education.
- To help students distinguish between values and skills
- To help students initiate a process of dialog within themselves to know what they 'really want to be' in their life and profession
- To help students understand the meaning of happiness within their selves.
- To help students understand the meaning of happiness and prosperity for a human being

COURSE OUTCOMES:

Upon completion of this course the students will be able to

- Illustrate the significance of value inputs in a classroom, distinguish between values and skills. K2
- Interpret the need, basic guidelines, content and process of value education, explore the meaning of happiness and prosperity and do a correct appraisal of the current scenario in the society K2
- Distinguish between the Self and the Body; understand the meaning of Harmony in the Self the Co-existence of Self and Body. K4
- Illustrate the value of harmonious relationship based on trust, respect and other naturally acceptable feelings in human-human relationships. K2
- Identify their role in ensuring a harmonious society. K3

UNIT I COURSE INTRODUCTION - NEED, BASIC GUIDELINES, CONTENT AND PROCESS FOR VALUE EDUCATION 5

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 5

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 5

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 HOURS: 15

TEXT BOOKS:

1. R R Gaur, R Sangal and G P Bagaria(2009).“A Foundation Course in Human Values and Professional Ethics”
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.
8. A N Tripathy, 2003, Human Values, New Age International Publishers.

SEMESTER – VII

24BEME701 PRINCIPLES OF MANAGEMENT AND ENGINEERING ETHICS 3H – 3C

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

End Semester Exam: 3 Hours

COURSE OBJECTIVE:

The goal of this course for students is

- To learn the functions of management in an organisation
- To impart knowledge on engineering ethics in practice
- To provide exposure on employee safety and rights

COURSE OUTCOMES:

Upon completion of this course the students will be able to

CO1:	Explain the managerial functions.	K2
CO2:	Compare the functions and principles of management theories.	K2
CO3:	Interpret the engineering ethics in an organization.	K2
CO4:	Discuss the social factors and social changes.	K2
CO5:	Outline the safety responsibilities and ethics.	K2

UNIT I HISTORICAL DEVELOPMENT, PLANNING, ORGANISING 9

Definition of Management – Management and Administration – Development of Management Thought – Contribution of Taylor and Fayol – Functions of Management – Steps involved in Planning – Objectives – Setting Objectives – Process of Managing by Objectives – Strategies, Policies and Planning Premises– Forecasting – Decision–making – Formal and informal organization – Organization Chart.

UNIT II DIRECTING AND CONTROLLING 9

Human Factors – Creativity and Innovation – Harmonizing Objectives – Leadership – Types of Leadership Motivation – Hierarchy of needs – Motivation theories – Motivational Techniques – Job Enrichment –Process of Communication – System and process of Controlling – Requirements for effective control – Control of Overall Performance – Direct and Preventive Control – Reporting

UNIT III ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' – variety of moral issued – types of inquiry – moral dilemmas – moral autonomy – Kohlberg's theory – Gilligan's theory – consensus and controversy – Models of Professional Roles – theories about right action – Self–interest – customs and religion – uses of ethical theories.

UNIT IV FACTORS OF CHANGES 9

Forces that shape culture, social control – Meaning, Agencies, Institution, Customs, Values, Folkways, Norms and Laws. Social changes – Meaning and nature – Theories.

UNIT V SAFETY RESPONSIBILITIES AND RIGHTS 9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination – Global issues - Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", 6th Edition, Pearson Education, 2004.
2. Stephen P. Robbins & Mary Coulter, "Management", Prentice Hall (India)Pvt. Ltd., 10 th Edition, 2009.

REFERENCES BOOKS:

1. Harold Koontz & Heinz Weihrich, "Essentials of Management", Tata McGraw Hill, 1998.
2. Robert Kreitner & Mamata Mohapatra, "Management", Biztantra, 2008.
3. Stephen A. Robbins & David A. Decenzo & Mary Coulter, "Fundamentals of Management", 7th Edition, Pearson Education, 2011.
4. Tripathy PC & Reddy PN, "Principles of Management", Tata Mcgraw Hill, 1999

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C401.1	2	1	-	-	-	-	-	-	2	2	3	1	1	-
C401.2	2	1	-	-	-	-	-	-	2	2	3	1	1	-
C401.3	2	1	-	-	-	-	-	-	2	2	3	1	1	-
C401.4	2	1	-	-	-	-	-	-	2	2	3	1	1	-
C401.5	2	1	-	-	-	-	-	-	2	2	3	1	1	-
C401	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**2.0**	**2.0**	**3.0**	**1.0**	**1.0**	**-**

SEMESTER – VII

24BEME702	OPERATIONS RESEARCH	3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Nil

COURSE OBJECTIVES:

The goal of this course for students is

- To provide students the knowledge of optimization techniques and approaches.
- To study the Engineering and Managerial situations in Transportation.
- To learn queuing theories and decision models to solve real time problems

COURSE OUTCOMES:

Upon completion of this course the students will be able to

CO1: Solve Linear programming technique in industrial optimization problems. K3
CO2: Solve the transportation problems using OR techniques. K3
CO3: Develop scheduling models for optimization. K3
CO4: Make use of inventory and queuing models in industrial applications. K3
CO5: Construct networks and group replacement models K3

UNIT I INTRODUCTION TO OPERATIONS RESEARCH 9

Operations research and decision–making – types of mathematical models and constructing the model – Role of computers in operations research –Linear Programming Techniques: Formulation of linear programming problem, applications and limitations, graphical method, simplex method – The Big –M method – the two– phase method.

UNIT II TRANSPORTATION PROBLEMS 9

Least cost method, North west corner rule, Vogel's approximation method, modified distribution method, unbalance and degeneracy in transportation model, shortest route algorithm – dijkestra algorithm.

UNIT III ASSIGNMENT MODELS AND SCHEDULING 9

Assignment models - Hungarian algorithm, unbalanced assignment problems - maximization case in assignment problems, traveling salesman problem. Scheduling – processing n jobs through two machines, processing n jobs through three machines, processing two jobs through 'm' machines, processing n jobs through m machines.

UNIT IV INVENTORY CONTROL AND QUEUING THEORY 9

Variables in inventory problems, inventory models with penalty, shortage and quantity discount, safety stock, multi-item deterministic model.

Queuing Models: Queues – Notation of queues, performance measures, The M/M/1 queue, The M/M/m queue, batch arrival queuing system, queues with breakdowns.

UNIT V PROJECT MANAGEMENT AND REPLACEMENT MODELS 9

Basic terminologies, constructing a project network, network computations in CPM and PERT, cost crashing Replacement Models: Replacement of Items due to deterioration with and without time value of Money, Group replacement policy, Staff replacement

TOTAL:45 PERIODS

TEXT BOOKS:

1. Kanti Swarup, Operations Research, 12th edition, Sultan Chand and Sons, New Delhi, 2010.
2. Viswanathan N and Narahari Y, Performance Modeling of Automated Manufacturing Systems,2nd edition,Prentice Hall of India, New Delhi, 2005.

REFERENCE BOOK:

1. Prem Kumar Gupta and Hira D.S, Operation Research, 1st edition, S Chand and Company Limited, NewDelhi, 2017.

WEBSITES

1.https://www.techtarget.com/whatis/definition/operations-research-OR
2. https://en.wikipedia.org/wiki/Operations_research

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C402.1	3	2	1	-	-	-	-	-	-	-	3	3	1	-
C402.2	3	2	1	-	-	-	-	-	-	-	3	3	1	-
C402.3	3	2	1	-	-	-	-	-	-	-	3	3	1	-
C402.4	3	2	1	-	-	-	-	-	-	-	3	3	1	-
C402.5	3	2	1	-	-	-	-	-	-	-	3	3	1	-
C402	**3.0**	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	3.0	3.0	**1.0**	**-**

SEMESTER – VII

24BEME7E01	**PROFESSIONAL ELECTIVE – VI**	**3H – 3C**

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

End Semester Exam: 3 Hours

SEMESTER – VII

24BEME791	**INTERNSHIP**	**0H – 2C**

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

End Semester Exam: 3 Hours

Students need to complete minimum 60 working days industrial internship during his/her Second and third year summer and winter vacation of UG program. Students may plan accordingly to avail industrial internship during summer and winter vacation except regular class days. And students should submit valid certificate and report for internal committee evaluation on his/her seventh semester.

SEMESTER – VII

24BEME792 PROJECT WORK PHASE – I 8H – 4C

Instruction Hours/week: L:0 T:0 P:8 **Marks:** Internal**:100** External**:00 T**otal**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Cultivate skills to innovate new ideas and select a suitable problem.
- Equip to apply subject knowledge to obtain solutions to real-world problems and explore the various solutions and propose a solution based on findings.
- Develop skills in project planning, scheduling, handling technical challenges and completing the project under constraints.

COURSE OUTCOMES:

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

- Outline the literature review.
- Apply subject knowledge to identify research gab.
- Identify the problem for research work.
- Explain the objectives.
- Build aim and title of the project work.

COURSE DESCRIPTION:

The students in a group consisting of a maximum of four or five students work on a topic approved by the Head of the Department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on the oral presentation and the project report by internal examiners constituted by the Head of the Department.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C405.1	2	1	-	-	1	1	1	1	2	2	-	2	2	-
C405.2	3	2	1	-	1	1	1	1	2	2	-	2	2	-
C405.3	3	2	1	-	1	1	1	1	2	2	-	2	2	-
C405.4	2	1	-	-	1	1	1	1	2	2	-	2	2	-
C405.5	3	2	1	-	1	1	1	1	2	2	-	2	2	-
C405	**2.60**	**1.60**	**1.00**	**-**	**1.00**	**1.00**	**1.00**	**1.00**	**2.00**	**2.00**	**-**	**2.00**	**2.00**	**-**

SEMESTER – VIII

24BEME891 PROJECT WORK PHASE – II 16H – 8C

Instruction Hours/week: L:0 T:0 P:16 **Marks:** Internal**:120** External**:180 T**otal**:300**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Cultivate skills to innovate new ideas and select a suitable problem.
- Develop skills in project planning, scheduling, handling technical challenges and completing the project under constraints.
- Develop skills to document the significant findings and outcomes.

COURSE OUTCOMES:

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

- Plan methodology according to research problem.
- Apply research knowledge to solve the problem.
- Analyze the data collected findings/ solutions /improvements
- Examine newer techniques to improve the performance of a device/system.
- Develop power point presentation and to face reviews and viva voce examination.

COURSE DESCRIPTION:

The students in a group consisting of a maximum of four students work on a topic approved by the Head of the Department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on the oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C406.1	3	2	1	-	2	2	1	1	3	3	2	2	3	2
C406.2	3	2	1	-	2	2	1	1	3	3	2	2	3	2
C406.3	3	3	2	1	2	2	1	1	3	3	2	2	3	2
C406.4	3	3	2	1	2	2	1	1	3	3	2	2	3	2
C406.5	3	2	1	-	2	2	1	1	3	3	2	2	3	2
C406	**3.00**	**2.40**	**1.40**	**1.00**	**2.00**	**2.00**	**1.00**	**1.00**	**3.00**	**3.00**	**2.00**	**2.00**	**3.00**	**2.00**

PROFESSIONAL ELECTIVE COURSES: VERTICAL 1

24BEMEXXXX COMPUTER AIDED MODELING AND MANUFACTURING 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Graphics, Geometric Tolerances and Drawing in Manufacturing

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To learn basics of design and two-dimensional drafting.
- Develop skills in three-dimensional modeling.
- To cultivate expertise in assembling modeling, computer aided machining and part programming.

COURSE OUTCOMES:

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

CO1:	explain the basics of the design and concepts.	K2
CO2:	generate two-dimensional drafting and projection views.	K3
CO3:	develop three-dimensional modeling,	K3
CO4:	execute assembly modeling.	K3
CO5:	perform machining operation with the aid of computer.	K2

UNIT – I BASICS OF DESIGNS 9

Understanding of Projections, Scales, units, GD & T; its 14 symbols, Special characteristics & Title Block readings. Revision / ECN status of drawings – Customer Specific requirements – Drawing Grid reading.

UNIT – II 2D DRAFTING 9

Projection views – Orthographic view, Axillary view, Full & Half Section views, Broken Section view, Offset Section view – Title Block creation – BOM Creation – Notes creation – Ballooning of 2D drawing and its features for Inspection reporting.

UNIT – III 3D MODELING 9

Conversion of Views – 2D to 3D & 3D to 2D – Parametric and Non-Parametric Modeling – Tree features of 3D Modeling and its advantages – Surface Modeling – BIW (Body in White) – Solid Modeling, Boolean operations like Unites, Subtraction, Intersect, etc.

UNIT – IV ASSEMBLY MODELING 9

Basics of Assembly modeling, Purpose of Assembly modeling & amp; its advantages – Top to Down & Bottom-Up modeling approaches – Analysis of Clearances – Undercuts – Interferences – Stack up analysis –Cumulative effect of Tolerances in after assembly conditions. - motion analysis.

UNIT – V CAM 9

Basics of CNC Machining – 3, 4 & 5 Axis machines - CNC and Part Programing, CAM programing 2D & 3D. Elements of CAM Orientation, Boundary Creation, Cutter Path Selection, Cutter Compensation –Machining Stocks, Roughing, Re-roughing, Semi Finishing & Finishing - Tool Path Generation, Isl and Milling Programing. Machining program simulation, integration of program with machine; Estimation of CNC Cycle time. – Post Process NC Code conversion and Setup Sheet Preparation.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Computer Aided Design & Manufacturing - Jacob Moses & Ruchi Agarwal.
2. CAD / CAM Principles & Application - J. Srinivas.

REFERENCES BOOKS:

1. CAD / CAM - Ibrahim Zaid (Text & Reference Book).
2. CAD / CAM – Chandandeep Grewal.
3. CAD CAM & Automation – Farazdak Haideri (Text & Reference Book).
4. Computer Aided Design & Manufacturing – Anup Goel.
5. CAD / CAM – PN Rao.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	-	-	-	-	1	-	-	1	3	2
Cxxx.2	3	2	1	-	-	-	-	-	1	-	-	1	3	2
Cxxx.3	3	2	1	-	-	-	-	-	1	-	-	1	3	2
Cxxx.4	3	2	1	-	-	-	-	-	1	-	-	1	3	2
Cxxx.5	2	1	-	-	-	-	-	-	1	-	-	1	3	2
Cxxx	**2.6**	**1.6**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**3.00**	**2.00**

PROFESSIONAL ELECTIVE COURSES: VERTICAL 1

24BEMEXXXX DESIGN FOR MANUFACTURE AND ASSEMBLY 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Graphics, Geometric Tolerances and Drawing in Manufacturing

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To learn the DFM approach in industry.
- To enrich skills in selective assembly and tolerancing theory.
- To gain knowledge in part design and tolerance charting.

COURSE OUTCOMES:

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

CO1:	implement DFMA in industry.	K3
CO2:	identify selective assembly procedures.	K3
CO3:	extract the nutshell of tolerancing theory.	K3
CO4:	perform form design.	K3
CO5:	develop tolerance charting	K3

UNIT I DFM APPROACH, SELECTION AND SUBSTITUTION OF MATERIALS IN INDUSTRY 9

DFM approach, DFM guidelines, standardization, group technology, value engineering, comparison of materials on cost basis, design for assembly, DFA index, Poka – Yoke principle; concept; Tolerance Analysis: Process capability, process capability metrics, Cp, Cpk , cost aspects, feature tolerances, geometric tolerances, surface finish, review of relationship between attainable tolerance grades and different machining process, cumulative effect of tolerances, sure fit law, normal law and truncated normal law.

UNIT II SELECTIVE ASSEMBLY 9

Interchangeable and selective assembly, deciding the number of groups, Model–I: group tolerances of mating parts equal; Model–II: total and group tolerances of shaft, control of axial play. Datum Systems: Grouped datum systems–different types, two and three mutually perpendicular grouped datum planes, grouped datum system with spigot and recess, pin and hole, and tongue–slot pair, computation of translational and rotational accuracy.

UNIT III TRUE POSITION TOLERANCING THEORY 9

Comparison between co–ordinate and convention method of feature location tolerancing and true position tolerancing, zero true position tolerance, virtual size concept, floating and fixed fasteners, projected tolerance zone, functional gauges, paper layout gauging, compound assembly, examples.

UNIT IV FORM DESIGN OF CASTINGS AND WELDMENTS 9

Redesign of castings based on parting line considerations, minimizing core requirements, redesigning cast members using weldments, use of welding symbols – design considerations for plastic component manufacturing.

UNIT V TOLERANCE CHARTING 9

Tolerance Charting Technique: Operation sequence for typical shaft type of components, preparation of process drawings for different operations, tolerance worksheets and centrality analysis, examples,

design features to facilitate machining. Datum features – functional and manufacturing, component design–machining considerations, redesign for manufacture, examples.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Harry Peck, Designing for Manufacture, 1 st edition, Pitman Publications, London, 1973
2. Gerhard Pahl, Wolfgang Beitz, Engineering Design – A Systematic Approach, 3rd Edition, Springer Science & Business Media, 2007.

REFERENCES BOOKS:

1. Spotts M F, Dimensioning and Tolerance for Quantity Production, 1st edition, Prentice Hall Inc., New Jersey, USA, 2008. (Digital)
2. Oliver R Wade, Tolerance Control in Design and Manufacturing, 1st edition, Industrial press Inc., New York, 2008
3. James G Bralla, Hand Book of Product Design for Manufacturing, 1st edition, McGraw Hill Publications, New Delhi, 2000. (Digital)
4. Clyde M. Creveling, Tolerance Design – A Hand Book for Developing Optimal Specifications, 1st edition, Prentice Hall, 2012.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	3	3	2	-	-	-	-	-	-	-	-	1	3	-
Cxxx.2	3	3	2	-	-	-	-	-	-	-	-	1	3	-
Cxxx.3	3	3	2	-	-	-	-	-	-	-	-	1	3	-
Cxxx.4	3	3	2	-	-	-	-	-	-	-	-	1	3	-
Cxxx.5	3	3	2	-	-	-	-	-	-	-	-	1	3	-
Cxxx	**3**	**3**	2	-	-	-	-	-	-	-	-	1	**3**	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 1

24BEMEXXXX PRODUCT LIFE CYCLE MANAGEMENT 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Nil

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To study the history, concepts and terminology in PLM
- To learn the functions and features of PLM/PDM
- To develop different modules offered in commercial PLM/PDM tools

COURSE OUTCOMES:

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

CO1:	summarize the history, concepts and terminology of PLM	K2
CO2:	describe the functions and features of PLM/PDM	K3
CO3:	analyze the case study on implementation of PLM/PDM tools.	K3
CO4:	identify the implementation procedures for PLM in industry.	K2
CO5:	customize the integration procedures for PLM/PDM with database interpreting software's.	K3

UNIT – I HISTORY, CONCEPTS AND TERMINOLOGY OF PLM 9

Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (cPDm), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM). PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.

UNIT – II PLM/PDM FUNCTIONS AND FEATURES 9

User Functions – Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration.

UNIT – III DETAILS OF MODULES IN A PDM/PLM SOFTWARE 9

Case studies based on top few commercial PLM/PDM tools – Team center, Wind chill, ENOVIA, Aras PLM, SAP PLM, Arena, Oracle Agile PLM and Autodesk Vault.-Architecture of PLM software-selection criterion of software for particular application - Brand name to be removed.

UNIT – IV ROLE OF PLM IN INDUSTRIES 9

Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for– business, organization, users, product or service, process performance- process compliance and process automation.

UNIT – V BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE 9

PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Product Lifecycle Management for a Global Market, Springer; 2014 edition (29 September 2016),ISBN-10 : 3662516330
2. Product Life Cycles and Product Management, Praeger Publishers Inc (27 March 1989)ISBN-10 : 0899303196

REFERENCES:

1. Antti Saaksvuori and AnselmiIm monen, “Product Lifecycle Management”, Springer Publisher, 2008 (3rd Edition)
2. Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House Publishers, 2003.
3. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007
4. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011 (2nd Edition).
5. Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	3	2	1	-	-	-	-	-	-	-	-	1	3	-
Cxxx.2	3	2	1	-	-	-	-	-	-	-	-	1	3	-
Cxxx.3	3	2	1	-	-	-	-	-	-	-	-	1	3	-
Cxxx.4	3	2	1	-	-	-	-	-	-	-	-	1	3	-
Cxxx.5	3	2	1	-	-	-	-	-	-	-	-	1	3	-
Cxxx	**3**	2	**1**	-	-	-	-	-	-	-	-	1	**3**	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 1

24BEMEXXXX HUMAN FACTORS ENGINEERING AND ERGONOMICS 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Mechatronics, Engineering Mechanics, engineering Thermodynamics

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To learn about the principles of human factors engineering, anthropometry, ergonomics and their impact in product design.
- To gain knowledge in developing the most efficient seating layout and machine controls for better working environment to humans.
- To provide the glimpse on the influence of workspace environment on human.

COURSE OUTCOMES:

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

CO1:	explain the fundamentals of Human factors, Physical work	K2
CO2:	develop anthropometric, ergonomic product.	K3
CO3:	generate an better ergonomic work space for humans.	K3
CO4:	identify effective work environment for human ergonomics.	K3
CO5:	Explain the measure of sound for better ergonomics	K2

UNIT I FUNDAMENTALS OF HUMAN FACTORS ENGINEERING 9

Human Biological, Ergonomic and psychological capabilities and limitations, Concepts of human factors engineering and Ergonomics, Man-Machine system and Design philosophy. Physical work and energy expenditure: Manual lifting, Work posture, Repetitive motion, Provision of energy for muscular work, Heat stress, Role of oxygen physical exertion, Measurement of energy expenditure, Respiration, Pulse rate and blood pressure during physical work, Physical work capacity and its evaluation.

UNIT II ANTHROPOMETRY, ERGONOMICS AND PRODUCT DESIGN 9

Physical dimensions of the human body as a working machine, Motion size relationships, Static and dynamic anthropometry, Anthropometric design principles, Using anthropometric measures for industrial design, Ergonomics in automated systems, Expert systems for ergonomic design, Anthropometric data and its application in ergonomic design, Limitations of anthropometric data, Use of computerized database.

UNIT III MACHINE CONTROLS, WORK PLACE AND SEATING DESIGN 9

Improvement of human work place through controls, Displays and Controls, Shapes and sizes of various controls and displays, Multiple display and control situations, Design of major controls in automobiles and machine tools, Principles of hand tool design, Design of office furniture, Redesign of instruments, Work process: Duration of rest periods, Design of visual displays, Design for shift work.

UNIT IV COLOR, LIGHT, TEMPERATURE-HUMIDITY-ILLUMINATION AND CONTRAST 9

Color and the eye, Color consistency, Color terms, Reactions to color and color continuation, Color on engineering equipment, Use of Photometers, Recommended illumination levels, the ageing eye, Use of indirect (Reflected) lighting, Cost efficiency of illumination. Special purpose lighting for illumination and quality control.

UNIT V MEASUREMENT OF SOUND 9

Noise exposure and hearing loss, Hearing protectors, Analysis and reduction of noise, Effects of noise, Performance annoyance of noise and interface with communication, Sources of vibration and performance effect of vibration.

TOTAL: 45 PERIODS

TEXT BOOK:

1. M. S. Sanders and E. J. McCormick, Human Factors in Engineering Design, VII Edition, McGraw Hill International, 1993
2. Salvendy, Gavriel, ed. Handbook of human factors and ergonomics. John Wiley & Sons, 2012.

REFERENCES BOOK:

1. P. V. Karpovich and W. E. Sinning, Physiology of Muscular Activity", VII Edition, Saunders (W.B.) Co Ltd., 1971.
2. Applied Ergonomics Handbook, I.P.C. Science and Technology Press Limited, 1974.
3. M. Helander, A Guide to the Ergonomics of Manufacturing, II Edition, CRC Press, 1997.
4. K. H. E. Kroemer, H. B. Kroemer, K. E. Kroemer Elbert, Ergonomics: How to design for ease and efficiency, II Edition, Pearson Publications, 2001

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	-	-	-	1	1	-	-	1	-	-
Cxxx.2	3	2	1	-	-	-	-	1	1	-	-	1	-	-
Cxxx.3	3	2	1	-	-	-	-	1	1	-	-	1	-	-
Cxxx.4	3	2	1	-	-	-	-	1	1	-	-	1	-	-
Cxxx.5	2	1	-	-	-	-	-	1	1	-	-	1	-	-
Cxxx	**2.6**	1.6	**1**	-	-	-	-	1	1	-	-	1	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 1

24BEMEXXXX PRODUCT DESIGN FOR MANUFACTURING 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Manufacturing processes and Manufacturing Technology

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To familiarize the concepts of product design
- To acquire knowledge in value engineering and design for manufacturing and assembly of a product
- To be competent with plant layout design, patenting and Rapid prototping

COURSE OUTCOMES:

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

CO1:	apply the concepts of product design to real-time applications	K3
CO2:	utilize value engineering and quality function deployment in product design	K3
CO3:	implement DFMA concepts in industry	K3
CO4:	develop effective plant layout and be a competent performer in applying patent	K3
CO5:	generate engineering models using rapid protyping.	K3

UNIT I INTRODUCTION 9

Design by Evolution - Design by innovation Production-Consumption cycle product realization process capital circulation manufacturing capability Interchangeability - product life cycle steps for engineering design process defining problem and setting objectives-developing provisional designs-decision making-morphology of design-product characteristics-developing products attributes-factors for successful products.

UNIT II VALUE ENGINEERING 9

Engineering materials - Importance of material selection-factors-procedures- manufacturing processes-primary-secondary-tertiary-selection of manufacturing process steps-types of value-Value engineering-methodology -function analysis system technique-steps-quality function deployment house of quality visual design elements principles - Aesthetic design-balance-proportions-Emphasis juxtaposition-Rhythm-unity.

UNIT III DESIGN FOR MANUFACTURING AND ASSEMBLY 9

Introduction- purpose of design review-Failure Mode and Effect Analysis-DFM guidelines - methods for evaluating design for assembly Method Time Measurements (MTM) standards- ages of disassembly process planning product recovery approach-evaluation of disassembly planning-Design for Environment stage process Computer Integrated Manufacturing- processes involved-benefits-CIM integration Reverse Engineering process-D scanning process.

UNIT IV PLANT LAYOUT DESIGN AND PATENTING 9

Plant layout factors-types-Cost and price structure-direct cost, indirect cost, design and manufacturing costs-Quality-factors-Statistical Process Control control chart - Design of Experiments acceptance sampling bench marking types process benefits out sourcing-mass customization-approaches-creativity-innovation types of copyright. types of patents-specifications of patent procedure for patent registration advantages of owning pa.

UNIT V RAPID PROTOTYPING 9

Rapid Prototyping process topography photo sculpture - concurrent engineering geometrical modelling technique-Stereolithography-Beam Interference Solidification-Solid Ground Curing-Holographic Interference Solidification-Electro setting- Ballistic Particle Manufacture Multi Jet Modelling Fused Deposition Modelling Shape Deposition Manufacturing - Selective Laser Sintering - Laser Engineering Net Shaping - Gas Phase Deposition Three Dimensional Printing - Laminated Object Manufacturing - Paper Lamination Technology – Applications.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Karl Ulrich, Steven Eppinger and Maria C. Yang, "Product design and development" McGraw-Hill Higher Education, 7th Edition, 2020.
2. Magrab, E.B., Gupta, S.K., McCluskey, F.P. and Sandborn, P., "Integrated Product and Process Design and Development: the product realization process" CRC Press, 2nd Edition, 2019.

REFERENCES BOOKS:

1. Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight, "Product Design for Manufacture and Assembly", CRC Press, 3rd Edition, 2010.
2. C. K. Chua, K. F. Leong and C. S. Lim, "Rapid Prototyping: Principles and Applications", Cambridge University Press, 2010.
3. Amitava Mitra, "Fundamentals of Quality Control and Improvement", Wiley, 3rd Edition, 2013.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	3	2	1	-	-	-	-	1	1	-	2	1	-	-
Cxxx.2	3	2	1	-	-	-	-	1	1	-	2	1	-	-
Cxxx.3	3	2	1	-	-	-	-	1	1	-	2	1	-	-
Cxxx.4	3	2	1	-	-	-	-	1	1	-	2	1	-	-
Cxxx.5	3	2	1	-	-	-	-	1	1	-	2	1	-	-
Cxxx	**3**	**2**	**1**	-	-	-	-	1	1	-	**2**	1	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 1

24BEMEXXXX DESIGN THINKING AND INNOVATION 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Nil

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To acquaint with design thinking principles.
- To gain knowledge in customer-centric product and design thinking tools
- To outline the principles of solution concepts and system thinking

COURSE OUTCOMES:

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

CO1:	elaborate the practice for a human centric design	K2
CO2:	excel in user centric innovation	K3
CO3:	apply design thinking tools in engineering applications.	K3
CO4:	develop skills in concept generation in designing a product.	K3
CO5:	implement system thinking in a complex systems.	K3

UNIT I DESIGN THINKING PRINCIPLES 9

Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR [Forge Innovation rubric] - Case studies

UNIT II ENDUSER-CENTRIC INNOVATION 9

Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and field visit.

UNIT III APPLIED DESIGN THINKING TOOLS 9

Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design.

UNIT IV CONCEPT GENERATION 9

Solution Exploration, Concepts Generation and MUP design- Conceptualize the solution concept; explore, iterate and learn; build the right prototype; Assess capability, usability and feasibility. Systematic concept generation; evaluation of technology alternatives and the solution concepts.

UNIT V SYSTEM THINKING 9

System Thinking, Understanding Systems, Examples and Understandings, Complex Systems.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Steve Blank, (2013), The four steps to epiphany: Successful strategies for products that win, Wiley.
2. Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, Alan Smith, Trish Papadakos, (2014), Value
3. Proposition Design: How to Create Products and Services Customers Want, Wiley

REFERENCES BOOKS:

1. Donella H. Meadows, (2015), "Thinking in Systems -A Primer", Sustainability Institute.
2. Tim Brown, (2012) "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Business.

WEB URLs:

1. https://www.ideou.com/pages/design-thinking#process
2.https://blog.forgeforward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca8624
3. https://blog.forgefor ward.in/product-innovation-rubric-adf5ebdfd356

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	-	-	-	1	1	-	1	1	-	-
Cxxx.2	3	2	1	-	-	-	-	1	1	-	1	1	-	-
Cxxx.3	3	2	1	-	-	-	-	1	1	-	1	1	-	-
Cxxx.4	3	2	1	-	-	-	-	1	1	-	1	1	-	-
Cxxx.5	3	2	1	-	-	-	-	1	1	-	1	1	-	-
Cxxx	**3**	**2**	**1**	-	-	-	-	1	1	-	**1**	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 1

24BEMEXXXX DESIGN CONCEPT IN ENGINEERING 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Nil

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To impart knowledge on various concepts in engineering design, material selection and manufacturing methods.
- To learn the principles of implementing quality and reliability in a product
- To familiarize with design of experiments concepts.

COURSE OUTCOMES:

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

CO1:	identify the various criteria in design process	K3
CO2:	apply the quality concepts to develop a robust product.	K3
CO3:	make use of failure mode effect analysis on a product and use six sigma principles to enhance its quality.	K3
CO4:	apply different experimental design methods in product development.	K3
CO5:	utilize various statistical tools to improve its quality and reliability	K3

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UNIT–I DESIGN FUNDAMENTALS, METHODS AND MATERIALSELECTION 9

Morphology of Design – The Design Process – Computer Aided Engineering – Concurrent Engineering – Competition Bench Marking – Creativity – Theory of Problem solving (TRIZ) – Value Analysis - Design for Manufacture, Design for Assembly – Design for casting, Forging, Metal Forming, Machining and Welding.

UNIT – II DESIGN FOR QUALITY 9

Quality Function Deployment -House of Quality-Objectives and functions-Targets- Stakeholders-Measures and Matrices-Design of Experiments –design process-Identification of control factors, noise factors, and performance metrics - developing the experimental plan-experimental design – testing noise factors- Running the experiments –Conducting the analysis-Selecting and conforming factor-Set points-reflecting and repeating.

UNIT – III FAILURE MODE EFFECTS ANALYSIS AND DESIGN FOR SIXSIGMA 9

Basic methods: Refining geometry and layout, general process of product embodiment - Embodiment check list-Advanced methods: systems modeling, mechanical embodiment principles-FMEA method-linking fault states to systems modeling – Basis of SIX SIGMA – Project selection for SIX SIGMA-SIX SIGMA problem solving- SIX SIGMA in service and small organizations - SIX SIGMA and lean production –Lean SIX SIGMA and services.

UNIT – IV DESIGN OF EXPERIMENTS 9

Importance of Experiments, Experimental Strategies, Basic principles of Design, Terminology, ANOVA, Steps in Experimentation, Sample size, Single Factor experiments – Completely Randomized design, Randomized Block design, Statistical Analysis, Multifactor experiments - Two and three factor full Factorial experiments, 2K factorial Experiments, Confounding and Blocking designs, Fractional factorial design, Taguchi's approach - Steps in experimentation, Design using Orthogonal Arrays, Data Analysis, Robust Design- Control and Noise factors, S/N ratios

UNIT – V STATISTICAL CONSIDERATION AND RELIABILITY 9

Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution-Statistical Process control– Scatter diagrams –Multivariable charts –Matrix plots and 3-D plots. -Reliability-Survival and Failure-Series and parallel systems-Mean time between failure-Weibull distribution.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Amitava Mitra, "Fundamentals of Quality control and improvement", John Wiley & Sons, 2016.
2. Montgomery, D.C., "Design and Analysis of experiments", JohnWileyandSons,2017.

REFERENCES:

1. George E.Dieter,LindaC.Schmidt,"EngineeringDesign",McGrawHillEducationPvt.Ltd., 2013
2. KarlT.Ulrich,StevenD.Eppinger,"ProductDesignAndDevelopment,,TataMcgraw-Hill Education, 2015
3. Kevin N. Otto and Kristin L. Wood, "Product Design: Techniques in Reverse Engineering and New Product Development", Prentice Hall, 2001
4. Phillip J. Ross, "Taguchi techniques for quality engineering", Tata McGraw Hill, 2005.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	**3**	**2**	**1**	-	-	-	-	-	-	-	1	1	-	-
Cxxx.2	3	2	1	-	-	-	-	-	-	-	1	1	-	-
Cxxx.3	3	2	1	-	-	-	-	-	-	-	1	1	-	-
Cxxx.4	3	2	1	-	-	-	-	-	-	-	1	1	-	-
Cxxx.5	3	2	1	-	-	-	-	-	-	-	1	1	-	-
Cxxx	**3**	**2**	**1**	-	-	-	-	-	-	-	**1**	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 2

24BEMEXXXX	SMART MOBILITY AND INTELLIGENT VEHICLES	3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Mechatronics, Basic Electrical and Electronics Engineering

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To introduce various technologies and systems used to implement smart mobility and intelligent vehicles.
- To learn sensor technology for smart mobility.
- To gain knowledge on Autonomous Automobiles.

COURSE OUTCOMES:

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

CO1:	recognize the methods to design an automated, connected and autonomous vehicle	K2
CO2:	select sensors for smart mobility	K3
CO3:	conceptualize connected autonomous vehicle	K2
CO4:	develop wireless communications systems for autonomous vehicle	K3
CO5:	identify the technical and moral needs for autonomous vehicle technology.	K2

UNIT – I INTRODUCTION TO AUTOMATED, CONNECTED, AND INTELLIGENT VEHICLES 9

Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicles.

UNIT – II SENSOR TECHNOLOGY FOR SMART MOBILITY 9

Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems.

UNIT – III CONNECTED AUTONOMOUS VEHICLE 9

Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy.

UNIT – IV VEHICLE WIRELESS TECHNOLOGY & NETWORKING 9

Wireless System Block Diagram and Overview of Components, Transmission Systems – Modulation/Encoding, Receiver System Concepts– Demodulation/Decoding, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks.

UNIT – V CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY 9

Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles - Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. "Intelligent Transportation Systems and Connected and Automated Vehicles", 2016, Transportation Research Board
2. Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", 2019, Springer.

REFERENCES BOOKS:

1. Tom Denton, "Automobile Electrical and Electronic systems, Roultedge", Taylor & Francis Group,5th Edition,2018.
2. Denton, Tom. Automobile electrical and electronic systems. Routledge, 2017.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	**2**	**1**	-	-	-	-	-	-	-	-	1	1	-	-
Cxxx.2	3	2	1	-	-	-	-	-	-	-	1	1	-	-
Cxxx.3	**2**	**1**	-	-	-	-	-	-	-	-	1	1	-	-
Cxxx.4	3	2	1	-	-	-	-	-	-	-	1	1	-	-
Cxxx.5	**2**	**1**	-	-	-	-	-	-	-	-	1	1	-	-
Cxxx	**2.4**	**1.4**	**1**	-	-	-	-	-	-	-	**1**	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 2

24BEMEXXXX INTRODUCTION TO INDUSTRIAL AUTOMATION SYSTEMS 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Mechatronics, Basic Electrical and Electronics Engineering

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To learn the architecture behind industrial automation
- To familiarize with application of computer in measurement
- To gain knowledge in PLC and DCS.

COURSE OUTCOMES:

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

CO1:	recognize architecture of an industrial automation system	K3
CO2:	categorize sensors for automation	K3
CO3:	identify the elements of computer aided measurements and its functions	K2
CO4:	utilize PLC in automation circuits.	K3
CO5:	Provide solutions using distributed control system	K3

UNIT I INTRODUCTION 9

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems: Modbus & Profibus.

UNIT II AUTOMATION COMPONENTS 9

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

UNIT III COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS 9

Role of computers in measurement and control, Elements of computer aided measurement and control, man- machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9

Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

UNIT V DISTRIBUTED CONTROL SYSTEM 9

Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. S.K.Singh, "Industrial Instrumentation", Tata Mcgraw Hill, 2nd edition companies,2003.
2. C D Johnson, "Process Control Instrumentation Technology", Prentice Hall India,8th Edition, 2006.
3. E.A.Parr, Newnes ,NewDelhi,"Industrial Control Handbook",3rd Edition, 2000.

REFERENCES:

1. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 5th Edition, Prentice Hall Inc., New Jersey, 2003.
2. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw- Hill, New York, 2016.
3. Krishna Kant, "Computer - Based Industrial Control", 2nd Edition, Prentice Hall, New Delhi, 2011.
4. Gary Dunning, Thomson Delmar,"Programmable Logic Controller", CeneageLearning, 3rd Edition,2005.

WEB URLs:

1. https://archive.nptel.ac.in/courses/108/105/108105062/
2. https://nptel.ac.in/courses/108105063
3. https://www.electrical4u.com/industrial-automation/

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	3	2	1	-	-	-	-	-	-	-	1	1	-	-
Cxxx.2	3	2	1	-	-	-	-	-	-	-	1	1	-	-
Cxxx.3	**2**	**1**	-	-	-	-	-	-	-	-	1	1	-	-
Cxxx.4	3	2	1	-	-	-	-	-	-	-	1	1	-	-
Cxxx.5	3	2	1	-	-	-	-	-	-	-	1	1	-	-
Cxxx	**2.8**	**1.8**	**1**	-	-	-	-	-	-	-	**1**	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 2

24BEMEXXXX EMBEDDED SYSTEMS AND PROGRAMMING 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Basic Electrical and Electronics Engineering

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To familiarize the architecture and fundamental units of microcontroller.
- To know the microcontroller programming methodology and to acquire the interfacing skills and data exchange methods
- To understand ARM processor and SBC architecture and its functions

COURSE OUTCOMES:

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

CO1:	explain the various functional units of microcontroller, processors and system-on-chip	K2
CO2:	identify the concept of internal interface of micro controllers	K2
CO3:	recognize the peripheral interfacing of hardware's with microcontroller	K2
CO4:	outline the constructional features of ARM Processor	K3
CO5:	describe the architecture of SBC and methods of programming embedded system	K3

UNIT I INTRODUCTION TO MICROCONTROLLER 9

Fundamentals Functions of ALU - Microprocessor - Microcontrollers – CISC and RISC – Types Microcontroller - 8051 Family - Architecture - Features and Specifications - Memory Organization - Instruction Sets – Addressing Modes.

UNIT II PROGRAMMING AND COMMUNICATION 9

Fundamentals of Assembly Language Programming – Instruction to Assembler – Compiler and IDE - C Programming for 8051 Microcontroller – Basic Arithmetic and Logical Programming - Timer and Counter - Interrupts – Interfacing and Programming of Serial Communication, I2C, SPI and CAN of 8051 Microcontroller – Bluetooth and WI-FI interfacing of 8051 Microcontroller.

UNIT III PERIPHERAL INTERFACING 9

I/O Programming – Interfacing of Memory, Key Board and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Traffic Light.

UNIT IV ARM PROCESSOR 9

Introduction ARM 7 Processor - Internal Architecture – Modes of Operations – Register Set – Instruction Sets – ARM Thumb - Thumb State Registers – Pipelining – basic programming of ARM – Applications.

UNIT V SINGLE BOARD COMPUTERS AND PROGRAMMING 9

System on Chip - Broadcom BCM2711 SoC – SBC architecture - Models and Languages – Embedded Design – Real Time Embedded Operating Systems - Real Time Programming Languages -– Python for Embedded Systems- GPIO Programming – Interfacing.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Frank Vahid and Tony Givagis, “Embedded System Design”, 2011, Wiley.
2. Kenneth J. Aylala, “The 8051 Microcontroller, the Architecture and Programming Applications”, 2003.

REFERENCES BOOKS:

1. Muhammad Ali Mazidi and Janice GillispicMazdi, “The 8051 Microcontroller and Embedded Systems”, Pearson Education, 2006.
2. Simon Monk, Programming the Raspberry Pi, Second Edition: Getting Started with Python McGraw Hill TAB; 2nd edition,20153. James W. Stewart, “The 8051
3. Microcontroller Hardware, Software and Interfacing”, Regents Prentice Hall, 2003.
4. John B. Peatman, “Design with Microcontrollers”, McGraw Hill International, USA, 2005.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	-	-	-	-	-	-	1	1	-	-
Cxxx.2	2	1	-	-	-	-	-	-	-	-	1	1	-	-
Cxxx.3	2	1	-	-	-	-	-	-	-	-	1	1	-	-
Cxxx.4	3	2	1	-	-	-	-	-	-	-	1	1	-	-
Cxxx.5	3	2	1	-	-	-	-	-	-	-	1	1	-	-
Cxxx	**2.4**	**1.4**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**

PROFESSIONAL ELECTIVE COURSES: VERTICAL 2

24BEMEXXXX **INDUSTRIAL ROBOTICS** **3H – 3C**

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

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To understand the fundamentals of robot.
- To learn the drives, end effectors and sensors used in robot.
- To familiarize robot kinematics, robot programming and economic analysis of robots.

COURSE OUTCOMES:

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

CO1:	identify the various types of robots.	K3
CO2:	select appropriate drive systems and end effectors for industrial application.	K3
CO3:	recognize the different types of machine vision technologies used in robot	K2
CO4:	outline the kinematics behind robot links and develop simple offline robot program for different applications	K3
CO5:	perform the economic analysis of robots.	K3

UNIT I FUNDAMENTALS OF ROBOT 9

Robot – Definition – Robot Anatomy – Co–ordinate Systems, Work Envelope, types and classification – Specifications – Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and Their Functions – Need for Robots – Different Applications.

UNIT II ROBOT DRIVE SYSTEMS AND END EFFECTORS 9

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of all these Drives End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT III SENSORS AND MACHINE VISION 9

Requirements of a sensor, Principles and Applications of the following types of sensors – Position sensors (Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, Pneumatic Position Sensors), Range Sensors (Triangulation Principle, Structured, Lighting Approach, Time of Flight Range Finders, Laser Range Meters), Proximity Sensors (Inductive, Hall Effect, Capacitive, Ultrasonic and Optical Proximity Sensors), Touch Sensors, (Binary Sensors, Analog Sensors), Wrist Sensors, Compliance Sensors, Slip Sensors Camera, Frame Grabber, Sensing and Digitizing Image Data – Signal Conversion, Image Storage, Lighting Techniques. Image Processing and Analysis – Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms. Applications – Inspection, Identification, Visual Serving and Navigation.

UNIT IV ROBOT KINEMATICS AND ROBOT PROGRAMMING 9

Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional), Four Degrees of Freedom (In 3 Dimensional) – Deviations and Problems. Teach Pendant Programming, Lead through programming, Robot programming Languages – VAL Programming – Motion Commands, Sensor Commands, End effecter commands, and Simple programs.

UNIT V IMPLEMENTATION AND ROBOT ECONOMICS 9

RGV, AGV; Implementation of Robots in Industries – Various Steps; Safety Considerations for Robot Operations; Economic Analysis of Robots – Pay back Method, EUAC Method, Rate of Return Method, Process application of Robots and Collaborative robots.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Ganesh.S.Hedge,"A textbook of Industrial Robotics", Lakshmi Publications, 2006.
2. Mikell.P.Groover , "Industrial Robotics – Technology, Programming and applications" McGraw Hill 2ND edition 2012.

REFERENCES BOOKS:

1. Fu K.S. Gonalz R.C. and ice C.S.G."Robotics Control, Sensing, Vision and Intelligence",
1. McGraw Hill book co. 2007.
2. YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.
3. Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.
4. John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.
5. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	3	2	1	-	-	-	-	-	-	-	1	1	-	-
Cxxx.2	3	2	1	-	-	-	-	-	-	-	1	1	-	-
Cxxx.3	2	1	-	-	-	-	-	-	-	-	1	1	-	-
Cxxx.4	3	2	1	-	-	-	-	-	-	-	1	1	-	-
Cxxx.5	3	2	1	-	-	-	-	-	-	-	1	1	-	-
Cxxx	**2.8**	**1.8**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**

PROFESSIONAL ELECTIVE COURSES: VERTICAL 2

24BEMEXXXX	**DIGITAL TECHNOLOGIES WITH CPS, IIOT AND CLOUD IN MANUFACTURING**	**3H – 3C**

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

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To learn the theoretical aspects of Digital Manufacturing
- To studt the Technological Impact of Digital Manufacturing
- To provide Industrial based case study in Digital Manufacturing

COURSE OUTCOMES:

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

CO1:	Understand the various technologies in Digital Manufacturing	K2
CO2:	Explain how the data is shared in Digital Manufacturing to simplify the process	K2
CO3:	Illustrate the basic concepts behind CPS and IIOT Technologies perspective	K2
CO4:	Summarize about smart factories, which connect the physical and digital worlds in order to monitor an overall production process.	K2
CO5:	Infer the fundamentals of Cloud Services and Artificial Intelligence in various engineering services.	K2

UNIT – I EVOLUTION OF INDUSTRY 4.0 AND SMART TOOLS 9

Introduction to Digital transformation- Evolution of digital manufacturing, Drivers of digital transformation, Introduction to Cyber physical system, Internet of things, Digital thread and twin

Evolution of Industry 4.0 – Origin of Industry 4.0, Key components, Connectivity of components, Design principles, Architecture models in Industry 4.0, Digital Resource Modelling and Simulation - Factory Model

Technology for Smart Design and Manufacturing - Geometric Modelling and kernals, Simulated motion analysis of Machine component, CAE -Implementation, Geometric Dimensioning and Tolerancing (GD&T).

UNIT – II SMART FACTORY 9

Digital Product life cycle (PLM) and Value Chain – Elements in PLM, Digital product life cycle, Connectivity of Enterprise Resource Planning (ERP), PLM platform, Digital Transformation of Supply chain, Integration of Value Chain

Digital enabled Applications -Robotic Process Automation (RPA), Robot work flow Management, Machine health monitoring, Smart material flow, Additive Manufacturing Process Chain, Process Selection of Additive Manufacturing

Smart Factory Initiatives - Smart Energy Management system, predictive maintenance, Horizontal vertical Integration in smart factory, Augmented reality, Quality Management 4.0

UNIT – III CYBER PHYSICAL SYSTEM (CPS) 9

Demystifying Cyber Physical Systems- Evolution of Processors, Making Processor Chips from Sand, Embedded Memory Systems, Sensors and Actuators in Cyber Physical Systems, Serial Communication and protocols in CPS

Design and Development of CPS - Interfacing Sensors with ARM Cortex Processor – Humidity, Temperature, Ultrasonic Distance Sensor, Sound, Current, Voltage, moisture and Hall effect sensors

Design of Robotic ARM – Degree of freedom in robots, controlling solenoids in Hydraulics and Pneumatics, Introduction to Ardiuno nano, Interfacing servo motor using ardiuno nano

Demo examples

UNIT - IV INDUSTRIAL INTERNET OF THINGS (IIOT) FUNDAMENTALS AND USE CASES 9

Technologies Building the Digital Transformation in Industries, Concept of Internet of Things; Drivers, Benefits and challenges of IoT; Overview of Industrial IoT ; Demo - Introduction to Panel Box, Temperature Monitoring; Pharma Industry; Botting Plant; Energy Monitoring in Casting process; Heavy Equipment Forging; Packaging Industry; Automotive Component Manufacturing; Aluminum Extrusions ; Fasteners - Production Monitoring; Aerospace Parts Manufacturing; Metal Stampings; Interfacing sensors in a CNC machine for Tool life monitoring; Robot Programming with the aid of Virtual Reality Platform.

UNIT – V FUNDAMENTALS OF CLOUD SERVICES AND ARTIFICIAL INTELLIGENCE (AI) 9

Cloud services - Relational model of cloud with Industry 4.0; Adoption Trends and Manufacturing Infrastructure; Building Blocks of Cloud Computing; Cloud Service Models: Paas, FaaS and CaaS

Implications of AI in Industry 4.0 - AI Layer in Digital Factory Framework, Fundamental of AI and Edge Devices, Scope of Machine learning (ML) in Digital Transformation, Preparing Data for Optimization in production manhours - Demo with EDA procedures, Deep Learning Techniques in Construction Industry Demo Exercises.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Fundamentals of Digital Manufacturing Science- Zude Zhou, Shane (Shengquan) Xie, Dejun Chen - Springer
2. Practical Guide to Digital Manufacturing- Wen-Jun Chris Zhang - Springer

REFERENCES BOOKS:

1. Digital Manufacturing and Assembly Systems in Industry 4.0- Divya Zindani, J. Paulo Davim, Kaushik Kumar- CRC Press Sensitivity: LNT Construction Internal Use
2. E. A. Lee and S. A. Seshia, Introduction to Embedded Systems - A Cyber-Physical Systems Approach, Second Edition, MIT Press, 2017
3. Industry 4.0, The Industrial internet of things- Alasdair Gilchrist- Apress

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	2	-	-	-	-	-	-	1	-	-
Cxxx.2	2	1	-	-	2	-	-	-	-	-	-	1	-	-
Cxxx.3	2	1	-	-	2	-	-	-	-	-	-	1	-	-
Cxxx.4	2	1	-	-	2	-	-	-	-	-	-	1	-	-
Cxxx.5	2	1	-	-	2	-	-	-	-	-	-	1	-	-
Cxxx	**2.8**	**1.8**	-	-	**2**	-	-	-	-	-	-	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 2

24BEMEXXXX COGNITIVE MANUFACTURING – AI AND MACHINE VISION 3H – 3C

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

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To study the basics of cognitive manufacturing.
- To gain knowledge in application of AI and ML in manufacturing.
- To familiarize with advance vision systems and their application in automation systems.

COURSE OUTCOMES:

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

CO1:	Understand the concepts of industrial evolution and smart factory through cognitive manufacturing frameworks.	K2
CO2:	Utilize the applications of artificial intelligent, cloud, data analytics in manufacturing sector.	K3
CO3:	Apply data visualization, machine learning and computer vision techniques for enhanced manufacturing processes.	K3
CO4:	Make use of advanced vision, augmented reality and applications of Computer Vision with OpenCV in industries.	K3
CO5:	Utilize machine vision with robots and the application of metrology inspection in various scenarios.	K3

UNIT – I COGNITIVE MANUFACTURING FRAMEWORK 9

Overview: Introduction to Intelligent Manufacturing, The Evolution of Industry: From 1.0 to 5.0, Foundations of Cognitive Manufacturing, From Automation to Autonomy: Cognitive Shift, Machine Vision fundamentals in Smart factory, Human-Machine collaboration, Digital Twins, Augmented reality and Virtual reality, AI and Machine Learning in Manufacturing

Smart factory: Smart Manufacturing Sensors in Industry 4.0, Temperature and Pressure Sensor, Vision and Image sensor, Force and Acceleration sensor, IOT sensor and wireless connectivity, Smart Environment and Gas sensor, Sensor Intelligence and Data Analytics

Fundamentals of IIoT: Simulating IIoT Operations, Fundamentals of Cisco Packet Tracer & IoT Components in CPT, IoT Architecture in CPT, network infrastructure, IoT Sensors with Local/remote Control, Smart Smoke Detection and fire prevention System, Smart Factory -Industrial Automation.

UNIT – II ARTIFICIAL INTELLIGENT, CLOUD, DATA ANALYTICS IN MANUFACTURING 9

Fundamental of Cloud Computing: Types, Services and Models, Architecture, Cloud Computing framework, Cloud Micro services, Benefits and Use Cases, Technological Impacts on Industry 5.0 on Smart Manufacturing

Data Analytics in Manufacturing Industry: Descriptive & Diagnostic Analytics, Predictive Analytics, Prescriptive Analytics, Integration of IoT in Manufacturing, Integration of Digital Twin, Risk Management in Manufacturing with data analytics, Case Study: Data Analytics on Billets in Steel Manufacturing, Data analytics scope in Oil and Gas Industry

Data Analytics: Machine Learning algorithms, ML Algorithm- Principle and types, IoT Data Collection - Heavy Equipment Forging, Automotive Component Manufacturing, Aerospace Parts Manufacturing, Regression Algorithm - Principle & Practicing, Classification Algorithms, Impacts of ML in O&G Industry - A Review.

UNIT – III DATA VISUALIZATION, MACHINE LEARNING AND COMPUTER VISION 9

Data Visualization: Data Preparation and Modeling, Fundamentals of Data Visualization, Configuring Power BI, Data Import & Preparation in Power BI, Visualizing Chart and Tables, Spatial Visualization, Demo Exercises using Power BI

Machine learning: Manufacturing Process Optimization and Safety Standards, Introduction to Quality Inspection, Predictive Maintenance Model, Overview of machine learning applications across diverse sectors of Industries, ML Algorithms, predicting component failures, Machine learning for supply chain optimization

Computer vision with OpenCV: Reading, writing and displaying images, Creating images and shapes, Drawing-with-Mouse, Cropping, Copying and Resizing an image, Converting to different color spaces, Watermarking images, Histograms of images, Image- Arithmetic Operations, Bitwise Operations, Thresholding.

UNIT – IV ADVANCED VISION, AUGMENTED REALITY AND APPLICATION 9 Advanced vision with OpenCV: Template Matching, Finding Waldo, Corner and Edge Detection, Grid and Blob Detection, Understanding Contours, Identifying Contours by Shape-Counting Circles and Ellipses, Feature Detection using SIFT, SURF, FAST, BRIEF and ORB algorithms

Applications of Computer Vision with OpenCV: Image Segmentation and the Watershed Algorithm, Contours Around the Coins, detection of car license plate in an image, Face Detection in an image, connecting to a USB Camera or a Laptop Camera and opening the recorded video, Face Detection in a video, Detect QR-Code, Object Tracking.

UNIT – V MACHINE VISION WITH ROBOTS AND DRONE, METROLOGY INSPECTION APPLICATION AND CASE STUDIES 9

Robotics: Robotic Pick-and-Place and Navigation, Vision Guided Assembly Line, automated seam tracking in Welding, Visual Tracking in Conveyor Systems, Painting and Surface Finishing, Human-Robot Collaboration

Drones: Inventory Management, defect detection, Site Surveillance and Progress Reporting, Facility Safety Monitoring, Visual Inspection and Maintenance of Machinery

Applications: Role of Machine Vision in Metrology, Automated Optical Inspection (AOI), Warehouse automation with Machine Vision, Machine Vision in Inline Inspection, Visual Analysis for Tool Wear Detection, Machine Vision Collaborative Features for Industry 4.0

Case Studies: Measurement based quality using Augmented reality, Machine vision based automatic inspection, Evaluation of NDT using AI/ML, Automated Weld Defect Detection Using AI and Machine Vision, AI-driven material selection and optimization for Pressure vessel, AR based remote assisted maintenance.

TOTAL: 45 PERIODS

TEXT BOOKS:

1.Changeable and Reconfigurable Manufacturing Systems- Hoda A. ElMaraghy, Springer, 2009, ISBN: 9781848820678.

2. Cognitive Sensors and IoT- Architecture, Deployment, and Data Delivery- Fadi Al-Turjman, CRC Press, 2017

REFERENCES BOOKS:

1. Machine Vision- Automated Visual Inspection: Theory, Practice and Applications,Jürgen Beyerer, Fernando Puente León, Christian Frese- Springer, 2016
2. Artificial Intelligence for Smart Manufacturing Methods, Applications, and Challenges- Kim Phuc Tran (Editor), Springer, 2023
3. Introducing Microsoft PowerBI- Alberto Ferrari, Marco Russo, Microsoft Corporation, 2016, ISBN: 9781509302758
4. OpenCV Essentials- Oscar Deniz Suarez, Ma del Milagro Fernández Carrobles, Noelia Vállez Enano, Gloria Bueno Garcia, 2014, ISBN: 9781783984251.

WEB URLs:

1. https://www.bristlecone.com/cognitive-manufacturing/

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.8**	**1.8**	1	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**

PROFESSIONAL ELECTIVE COURSES: VERTICAL 2

24BEMEXXXX	**COLLABORATIVE ROBOTIC IN MANUFACTURING WITH AI, ML, IIOT**	**3H – 3C**

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

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Create awareness on the application of sensor and Transducer Technology in robotics.
- To learn fluid power systems, Robotic configurations and robot programming.
- To impart knowledge in robot design, manufacturing and interfacing computer with robot system.

COURSE OUTCOMES:

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

CO1:	Understand different sensors, actuators, and fluid systems	K2
CO2:	Develop a hydraulic system for Industrial Applications	K3
CO3:	Experiment with the Kinematic and Dynamics of Robotic configurations	K3
CO4:	Develop a robot with the inclusion of latest technologies for specific tasks	K3
CO5:	Make use of electronics and do simulation for the developed Robot	K3

UNIT – I SENSOR TECHNOLOGIES IN M/C TOOLS & ROBOTS 9

Evolution of Mechatronics and its importance, Range of sensors from Domestic appliances to Machinery on the shop floor, Sensors in Machine tools, Sensors in Robots, Standards & specifications of sensors, Interfacing sensors in a CNC Machine for Tool life monitoring, and advanced Mechatronics systems in Machines Open & closed-loop control systems, Digital Motors, Servo Motors, Characteristics, Various electrical drives in powering different machine tools, and Troubleshooting in Electrical Drives Control systems, digital electronics and instrumentation in Robotics & Cobots in Manufacturing

UNIT – II INDUSTRIAL FLUID SYSTEMS 9

Hydraulic actuators for heavy and light-duty applications, Pneumatic actuators for Machine tools, Hydro Pneumatic Actuators, Intensifiers, and Accumulators in Fluid system applications. Essential Pneumatic and Hydraulic circuit components, Hydraulic and Pneumatic circuits for cascading operations in machine tools, Design of Electro- Hydro-Pneumatic Circuits, Circuits for synchronizing, Regenerating & sequential industrial operations, Control systems in fluid circuits to operate Machine tools, A fluid system for Industrial Robots, Fluidics and Logic circuits in Machine tools, and Trouble Shooting in the Drive system.

UNIT – III ROBOTIC ENGINEERING & VISION SYSTEMS 9

Robotic configurations, Robotic grippers with sensing capabilities, Robot Kinematics and Control, Denavit - Hartenberg convention, Robot Dynamics, Trajectory Planning, Motion control systems, Mentoring the robots, Robot Programming relevant to Industrial applications, and Robotic Intelligence in Manufacturing. Robotic Vision sensors, Frame Grabbing, Sensing and Digitizing, Image Processing, Enhancement, Object recognition & Algorithms, Robot operating systems, and Applications of Robotic vision systems.

UNIT – IV ROBOTIC DESIGN CONSIDERATIONS & MANUFACTURING 9

Materials used in the Fabrication of a Robot, Selection and Design Criteria, Application-based Grippers and their design, Energy Supply to Robots, and Robot communication

Robotic Manufacturing, Various Engineering concepts associated with Robot cantered manufacturing, Expert systems and Cognitive manufacturing.Automated Guided Vehicles, Types of AGVs, Traffic management & Control, Rail Guided Vehicles, and Applications of robots in various fields**.**

UNIT – V INTERFACING AND SIMULATION 9

Micro Processors, Microcontrollers, and Programmable Logic Controllers. Mechatronics system design, Utilizing IoT in Mechatronics systems, Artificial Intelligence and Machine learning nuances in Robotic environment, Data Applications in Manufacturing, Embedded systems, and the Role of Fuzzy logic in Manufacturing. Design of Robot link using MAT Lab Simulink and Design of RR Robot Forward Kinematics using MAT Lab Simulink.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Fundamentals of robotics – Analysis and control- Robert. J. Schilling, Prentice Hall of India 1996.
2. Introduction to Robotics (Mechanics and control), John. J. Craig, Pearson Education Asia 2002.
3. Fluid Power with Applications-Anthony Esposito- Pearson Publications

REFERENCES BOOKS:

1.Pneumatic Control for Industrial Automation‖, Peter Rohner & Gordon Smith, John Wiley and Sons, 1987
2. Fundamentals of Digital Manufacturing Science- Zude Zhou, Shane (Shengquan) Xie, Dejun Chen – Springer
3. Pneumatic Control for Industrial Automation‖, Peter Rohner & Gordon Smith, John Wiley and SONS, 1987

WEB URLs:

1. https://www.automate.org/robotics
2. https://www.ieee-ras.org/
3. https://www.twi-global.com/Digital Manufacturing

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.8**	**1.8**	1	-	**1**	-	-	-	-	-	-	**1**	-	-

ROFESSIONAL ELECTIVE COURSES: VERTICAL 3

24BEMEXXXX SMART MANUFACTURING 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Mechatronics and Manufacturing Technology

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Impart knowledge of smart manufacturing for industry 4.0 and its allied technologies
- Explore the digitalization techniques in manufacturing processes
- Develop skills to face the challenges and opportunities in smart manufacturing systems

COURSE OUTCOMES:

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

CO1:	Discuss on the concepts of Smart Manufacturing and its relevance	K2
CO2:	Apply the smart manufacturing concepts in manufacturing industry	K3
CO3:	Summarize the operations of a smart manufacturing industry	K3
CO4:	Integrate AI in smart manufacturing	K3
CO5:	Provide solutions in problems in industrial applications	K2

UNIT-I: INTRODUCTION TO SMART MANUFACTURING 9

Definition – objectives - Evolution of manufacturing systems - Key components and technologies in Smart Manufacturing - Basic principles and technologies of a Smart manufacturing - Nine Pillars of Smart Manufacturing - Ecosystem required for Smart Manufacturing - Skill set required for Smart Manufacturing - Effects on 4 M- Man, Machine, Materials & Methods in Smart Manufacturing - Benefits of Smart Manufacturing - Emerging trends in Smart Manufacturing.

UNIT-II: SMART DESIGN & FABRICATION 9

Smart Design/Fabrication - Digital Tools - Industrial Automation and Control Systems - Mass Customization, Smart Machine Tools - Smart work piece - Digital Twins in production - Robotics and Automation (perception, manipulation, mobility, autonomy), Smart Perception – Sensor networks and Devices - Smart Energy Management of manufacturing processes and facilities - Cyber-Physical Systems and Cyber Physical Production Systems.

UNIT-III: SMART FACTORY 9

Introduction to Smart Factory - Cloud Computing strategies in Smart Factories - Cyber Security - Smart Energy Management - Track and Trace Technology - Remote Monitoring - Horizontal & Vertical Integration Smart Logistics and supply chain - Connected Factory in smart manufacturing - Predictive Maintenance and Quality Management.

UNIT-IV: ML IN MANUFACTURING ML 9

ML - Concept of AI - Conceptual Learning, AI & Augmented reality in Manufacturing - ANN in Manufacturing - Biological Neuron - Artificial Neuron – Types of NNs - ML Applications in Manufacturing - Human-Robot Collaboration - Communication Systems in Cloud Manufacturing - Cloud Applications in Manufacturing, and allied factory

UNIT- V: APPLICATIONS AND CASE STUDIES 9

Factories and Assembly Line - Food Industry – Medical - Power Plants - Inventory Management & Quality - Data Acquisition and Analysis – Case Studies

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Luo Z, Smart Manufacturing Innovation and Transformation: Interconnection and Intelligence, IGI Global, 2014.
2. Masoud Soroush, McKetta Michael Baldea, & Thomas Edgar, Smart Manufacturing: Concepts and Methods, Elsevier, 2020.

REFERENCE BOOKS:

1. Rajesh Agnihotri Samuel, Industry 4.0 Data Analytics, CreateSpace Independent Publishing Platform, 2016.
2. Rawat DB ,Brecher C ,Song H,Jeschke S, Industrial Internet of Things: Cyber manufacturing Systems, Springer, 2017
3. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, A Press, 1st edition, 2016.
4. Kuniavsky M, Smart Things: Ubiquitous Computing User Experience Design, Morgan Kaufmann; First edition, 2016.
5. Groover M P, Automation, Production Systems and CIM, Prentice Hall India, 2007.
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CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.6**	**1.6**	1	-	**1**	-	-	-	-	-	-	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 3

24BEMEXXXX	GREEN AND SUSTAINABLE MANUFACTURING	3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Manufacturing Technology

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To be acquainted with sustainability in manufacturing
- To acquire knowledge in environment and social sustainability.
- To provide knowledge on strategies to achieve sustainability.

COURSE OUTCOMES:

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

CO1:	Explain the concepts of sustainable manufacturing	K2
CO2:	Discuss on the technologies involved in sustainable manufacturing	K2
CO3:	Comment on the sustainable practices and its measurements	K3
CO4:	Describe the sustainable practices in manufacturing	K3
CO5:	Explain the recent in sustainable operations and its applications	K3

UNIT I INTRODUCTION **9**

Concept of sustainability, manufacturing operations, resources in manufacturing. Concept of triple bottom line, environmental, economic and social dimensions of sustainability. Relation between green, lean and sustainable manufacturing.

.**UNIT III SUSTAINABLE MANUFACTURING TECHNOLOGIES** **9**

Introduction – Sustainable Manufacturing Technologies – Dry Machining and Near Dry Machining (MQL) – Challenges of implementing Dry Machining and Minimum Quantity Lubrication – Remanufacturing - Cryogenic Machining – High Pressure Jet Assisted Manufacturing – Machining Process Sustainability.

UNIT III SUSTAINABILITY PRACTICES **9**

Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modelling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers - Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements – Cost and time model.

UNIT IV MANUFACTURING STRATEGY FOR SUSTAINABILITY **9**

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs

UNIT V TRENDS IN SUSTAINABLE OPERATIONS **9**

Principles of sustainable operations - Life cycle assessment manufacturing and service activities - Influence of product design on operations - Process analysis - Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being

TOTAL: 45 PERIODS

TEXT BOOKS:

1. David Dornfeld, Chris Yuan, Chris Yuan, Green Manufacturing: Fundamentals and Applications, Springer US,2013.
2. Jiri Klemes, Ferenc Friedler, Igor Bulatov, Petar Varbanov .Sustainability in the Process Industry: Integration and Optimization (Green Manufacturing & Systems Engineering) McGraw-Hill Professional, 2010

REFERENCE BOOKS:

1. Atkinson G, Dietz S, Neumayer E, Handbook of sustainable manufacturing, Edward Elgar Publishing limited, 2007.
2. Domnita Fratila ,J. Paulo Davim, Green Manufacturing Processes and Systems, Springer-Verlag Berlin Heidelberg, 2013.
3. Klemes J, Sustainability in the process industry, McGraw Hill, 2011.
4. Found, Pauline; Pampanelli, Andrea; Trivedi, Neil The green factory: creating lean and sustainable manufacturing, CRC Press,2016.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.6**	**1.6**	1	-	**1**	-	-	-	-	-	-	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 3

24BEMEXXXX ADVANCED MACHINING PROCESSES 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Manufacturing Technology and Manufacturing Processes

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To impart knowledge about the significance of unconventional manufacturing processes
- To introduce the basics of /rapid prototyping and its applications
- To impart knowledge on micro fabrication techniques

COURSE OUTCOMES:

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

CO1: Explain the working of mechanical energy based unconventional manufacturing processes K2

CO2: Illustrate the working of thermal energy based unconventional manufacturing processes K2

CO3: Discuss the significance of rapid prototyping and its applications K3

CO4: Summarize the working of micro and nano fabrication techniques K2

CO5: Comment on the appropriate advanced finishing process suitable for a product K3

UNIT I MECHANICAL ENERGY BASED ADVANCED MACHINING PROCESSES 9

Introduction, need, Abrasive Jet Machining (AJM), Parametric Analysis, Process capabilities, Ultrasonic Machining (USM) – Mechanics of cutting, models, Parametric Analysis, Water Jet Machining (WJM) – principle, equipment, process characteristics, Performance, Electrical Discharge Machining (EDM) – principles, equipment, generators, analysis of R-C circuits, MRR, Surface finish, Laser Beam Machining (LBM) - construction, working, process parameters, merits, demerits and applications, (EBM) - construction, working, process parameters, merits, demerits and applications

UNIT II THERMAL ENERGY BASED ADVANCED MACHINING PROCESSES 9

Laser Beam Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Plasma Arc Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Electron Beam Machining - Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Electro Chemical Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications

UNIT III RAPID PROTOTYPING 9

Rapid prototyping fabrication methods – Fundamentals – Technologies – Applications - Principles and working of 3D printing - subtractive v/s additive manufacturing process - VAT photo polymerization - Material and binder jetting - Direct metal laser sintering.

UNIT IV MICRO FABRICATION TECHNIQUES 9

Technologies of micro fabrication, types of micro system devices, industrial applications, micro fabrication processes, LIGA process, Technologies of nano fabrication, importance of size, scanning probe microscope, carbon Buckyballs and nano tubes, nano fabrication processes.

UNIT V ADVANCED FINISHING PROCESS **9**

Abrasive Flow Machining (AFM) – Magnetic Abrasive Finishing (MAF) – Magneto-rheological Finishing (MRH) – Chemo Mechanical Polishing (CMP) – Working principle – Mechanism of material removal Surface quality – Applications

TOTAL: 45 PERIODS

TEXTBOOKS:

1. V. K. Jain, Advanced Machining Processes Allied, Publishers,2009.
2. Gary F. Benedict, Nontraditional Manufacturing Processes, Taylor & Francis1987.

REFERENCE BOOKS:

1. J. A. McGeough, Advanced Methods of Machining, Springer, 1988.
2. P K Mishra, Non-Conventional Machining, Narosa India Publication, 1997.
3. P. C. Pandey and H. S. Shan, Modern Machining Processes, Tata McGraw-Hill Education, First Edition, 2017.
4. V. K. Jain ,Introduction to Micromachining, Alpha Science International Ltd; Second edition,2017.
5. J. A. McGeough, Micromachining of Engineering Materials, CRC Press,2001.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.4**	**1.4**	1	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**

PROFESSIONAL ELECTIVE COURSES: VERTICAL 3

24BEMEXXXX ADDITIVE MANUFACTURING 3H – 3C

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

End Semester Exam: 3 Hours

PRE REQUISITE: Manufacturing Processes

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To learn about the principles of additive manufacturing systems
- To impart knowledge on the characteristics of additive Manufacturing technologies
- To have an idea on the applications of additive manufacturing processes

COURSE OUTCOMES:

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

CO1: Explain the concepts of additive manufacturing and its significance. K2

CO2: Comment on reverse engineering and its effectiveness K2

CO3: Select appropriate solid and liquid based additive manufacturing methods for the given applications K3

CO4: Identify suitable powder based AM techniques for the given applications K3

CO5: Suggest AM methods for bio medical applications K3

UNIT I INTRODUCTION 9

History of Additive Manufacturing (AM) – Need – Classification – AM in product development – Materials used in AM – Tooling – Pre and post processing - Merits, demerits and applications – Recent advancements.

UNIT II CAD AND REVERSE ENGINEERING 9

Basics of CAD – Digitization techniques – Model reconstruction – Data processing for additive manufacturing - CAD model preparation – Part orientation and support generation – Model slicing – Tool path generation.

UNIT III LIQUID AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 9

Liquid based system – Stereolithography Apparatus (SLA) – Principle, process, advantages and applications. Solid based system – Fused deposition modeling – Principle, process, advantages and applications. Laminated object manufacturing.

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS 9

Selective Laser Sintering (SLS) – principles, process and applications – Three dimensional printing – principle, process, advantages and applications – Laser Engineered Net Shaping (LENS) –Electron beam melting

UNIT V MEDICAL AND BIO ADDITIVE MANUFACTURING 9

Customized implants and prosthesis: Design and production – Bio-Additive manufacturing – Computer Aided Tissue Engineering (CATE) – Rapid tooling - Case studies.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Dr. Ian Gibson, Dr. David W. Rosen, Dr. Brent Stucker, Additive Manufacturing Technologies, Springer International Publishing, Third Edition,2020.
2. Amit Bandyopadhyay, Susmita Bose ,Additive Manufacturing CRC Press USA, Second Edition,2019.

REFERENCE BOOKS:

1. Chua C K,Leong K F and Lim C S3D Printing and Additive Manufacturing: Principles and Applications World Scientific Publishers Singapore, 2017.
2. Rafiq I. Noorani Rapid Prototyping: Principles and Applications CRC Press, USA2017
3. G. K. Awari, C. S Thorat, Vishwjeet Ambade, D. P. Kothari Additive Manufacturing and 3D Printing Technology: Principles and Applications CRC Press, USA2021
4.Manu Srivastava,Sandeep Rathee,Sachin Maheshwari,TK Kundra Additive Manufacturing Fundamentals and Advancements CRC Press, USA2019
5. Rupinder Singh,J. Paulo Davim Additive Manufacturing Applications and Innovations CRC Press, USA2021.

WEB URLs:

1. www.springer.com/cda/content/document/cda
2. http://textofvideo.nptel.iitm.ac.in/112102101/lec51.pdf
3. http://web.iitd.ac.in/~pmpandey/MEL120_html/RP_document.pdf
4. www.asminternational.org/documents/10192/1882071/amp16503p045.pdf
5. www.nptel.ac.in/courses/102106036/

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.6**	**1.6**	1	-	**1**	-	-	-	-	-	-	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 3

24BEMEXXXX	COMPUTER INTEGRATED MANUFACTURING	3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Mechatronics and Manufacturing Technology

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To acquire knowledge on the concepts of computer integrated manufacturing process.
- To comprehend the applications of group technology and computer aided process planning.
- To provide the adequate knowledge on flexible manufacturing systems and industrial robotics.

COURSE OUTCOMES:

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

CO1:	Explain the basic concepts of computer integrated manufacturing processes	K2
CO2:	Apply the concept of computer aided process planning and MRP	K3
CO3:	Apply the principles of group technology	K3
CO4:	Examine the applications of flexible manufacturing systems.	K3
CO5:	Comment on the applications of robotics in industrial automation	K2

UNIT I INTRODUCTION **9**

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerised elements of CIM system – Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements ofan Automated system – Levels of Automation – Lean Production and Just-In-Time Production.

UNIT II COMPUTERISED PROCESS PLANNING **9**

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP)

UNIT III CELLULAR MANUFACTURING **9**

Group Technology (GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems.

UNIT IV FLEXIBLE MANUFACTURING SYSTEM **9**

Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control – Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

UNIT V INDUSTRIAL ROBOTICS **9**

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Mikell P. Groover Automation, Production Systems, and Computer-Integrated Manufacturing Pearson Education, Fifth Edition2024.
2. Vajpayee, S. Kant, Principles of Computer - Integrated Manufacturing ,PHI Learning,2013.

REFERENCE BOOKS:

1. V.D. Hunt Computer-Integrated Manufacturing Handbook Springer-Verlag New York Inc2011.
2. R. Panneerselvam P. Senthilkumar P. Sivasankaran, Computer-integrated Manufacturing: Automation in Manufacturing Cengage India, First Edition2020.
3. Alavudeen A Venkatehwaran N ,Computer Integrated Manufacturing, PHI Learning,2008.
4. Robert U. ,Ayres Computer Integrated Manufacturing: Volume I: Revolution in Progress Springer2013.
5. Sushil Kumar Choudhary R. S Jadoun Computer Integrated Manufacturing & Computer Aided Manufacturing Walnut Publication, First Edition2021

WEB URLs:

1. http://nptel.ac.in/courses/112103174/module1/lec2/3.html
2. www.ignou.ac.in/upload/UNIT6-55.pdf
3. http://nptel.ac.in/courses/105103023/39
4. www.cax.szm.com/doc/capp.doc
5. www.ignou.ac.in/upload/Unit-12-55.pdf

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.6**	**1.6**	1	-	**1**	-	-	-	-	-	-	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 3

24BEMEXXXX FLEXIBLE MANUFACTURING SYSTEMS 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Mechatronics and Manufacturing Technology

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To impart the concept and need for flexibility in manufacturing industries.
- To learn the concepts in group technology.
- To gain knowledge in implementing FMS.

COURSE OUTCOMES:

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

CO1: Explain the fundamentals of flexible manufacturing system. K2
CO2: Summarize the significance of group technology in an industry K3
CO3: Select material handling and retrieval systems for specific application. K3
CO4: Choose relevant manufacturing approach required for a particular industry. K3
CO5: Suggest suitable software module for flexible manufacturing system. K2

UNIT I INTRODUCTION 9

Introduction to FMS – FMS Types – FMS Layouts – Objectives of FMS – Advantages and Disadvantages – Applications – Manufacturing Cell – Classification of Cell – Unattended Machining – Difference between FMS and FMC.

UNIT II GROUP TECHNOLOGY 9

Group Technology (GT) – Introduction, Role of GT in CAD/CAM Integration – Part families – Production flow analysis – Parts classification and coding – OPTIZ class – Machine Class – D Class – Benefits of GT – Obstacles -Machine Cell Design

UNIT III CELLULAR MANUFACTURING 9

Automated Material Handling – Functions – Types – Analysis of material handling equipment – Design of conveyor and AGV systems – Benefits – Storage system performance – Automated Storage and retreival system (AS/RS) – Carousel storage system – Work-In-Progress (WIP) storage system – Interfacing handling and storage with manufacturing.

UNIT IV FLEXIBLEMANUFACTURINGSYSTEM 9

Aggregate production planning and master production schedule – Material Requirement Planning (MRP) – Just-In-Time (JIT): Definition – Concept – Objectives – Goals – Seven wastes – Implementation – Kanban card system: Push vs Pull system – Types .

UNIT V FMS SOFTWARE 9

FMS Software – Requirements – Types of FMS software modules – FMS Installation – FMS Implementation – Case Studies.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Mikell P Groover Automation, Production Systems, and Computer- Integrated Manufacturing Pearson Education, Fifth Edition2024.
2. William W Luggen ,Flexible Manufacturing Cells and Systems, Prentice Hall, Fourth Edition,2016.

REFERENCE BOOKS:

1. Shivanand H K Benal M M and Koti V Flexible Manufacturing System Butterworth Heinemann,First Edition Reprint2016.
2. Kant Vajpayee S Principles of Computer Integrated Manufacturing Wiley, Eighth Edition2007.
3. Radhakrishnan P and Subramanyan S CAD/CAM/CIM Academic Press, Third Edition2001.
4. Taiichi Ohno Toyota Production System: Beyond large-Scale production Productivity Press1992.
6. Jha N K Handbook of Flexible Manufacturing System Academic Press1996

WEB URLS:

1. www.mechscience.com/major-elements-of-fms-flexible-manufacturing-system/
2. www.revotechnologies.net/uploads/1/6/0/7/16078520/unit_iii-acim.pdf
3. www.conveyco.com/automated-storage-and-retrieval-types/
4. www.nptel.ac.in/courses/112103174/module1/lec2/3.html
5. www.nptel.ac.in/courses/110106044/37

TOTAL: 45

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.6**	**1.6**	1	-	**1**	-	-	-	-	-	-	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 3

24BEMEXXXX **LEAN MANUFACTURING** **3H – 3C**

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Manufacturing Technology

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To understand the principles of lean manufacturing.
- To learn about value stream mapping and its methods.
- To learn strategy / methodology in industries

COURSE OUTCOMES:

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

CO1:	Explain the principles of lean manufacturing	K2
CO2:	Apply value stream mapping concept in industries	K3
CO3:	Discuss the concepts of lean manufacturing in industries	K3
CO4:	Comment on the principles of lean management	K3
CO5:	adopt lean management strategies in relevant applications	K3

UNIT I INTRODUCTION TO LEAN MANUFACTURING 9

Conventional manufacturing versus Lean manufacturing – Principles of lean manufacturing – Basic elements of lean manufacturing – Introduction to LM tools – Agile manufacturing definition – Business need – Conceptual frame work – Characteristics and generic features – Developing agile manufacturing enterprise – Strategies – Integration of organization – Workforce and technology – Reference models – Examples.

UNIT II VALUE STREAM MAPPING 9

Definition – VSM types – Product family – Selection value stream manager – Current state map – process box – Value stream icons – 3 Ms – Muda, Mura, Muri – 7 Types of Muda – Future state map – Value stream plan – Process stability – Loss reduction – 7 Major losses reduction – Demand stage: Market dynamics – Customer demand – PQ analysis – PR analysis – TAKT time – Pitch – Finished goods stock – Cycle stock – Buffer stock – Safety stock – Applications strategies.

UNIT III LEAN MANAGEMENT 9

Management of complexities and information – Flow – Approaches – Applications of multimedia to improve agility in manufacturing – System concepts – Principles – IT/IS concepts in supply chain management – Enterprise integration and management in agile manufacturing – Concepts – Agility – Adaptability and learners – Comparison of concepts.

UNIT IV INDUSTRIAL LEAN STRATEGIES 9

Capacity planning and production line design – Redesign in agile manufacturing – Cellular manufacturing – Concepts – Examples. Set up time reduction – Definition, philosophies, and reduction approaches – TQM – Principles and implementation – 5S Principles and implementation – Identify lean metrics– Steps involved in Goal Setting – Corporate goals – Kaizen cloud identification in VSM .

UNIT V LEAN ASSESSMENT STRATEGIES 9

Lean assessment – Cultural Change – Reviews – Recognition – Improving targets and benchmarks – Enhancing technology for machine tool system – Resumption of design requirement geometry – Definition and methods – Decision support for selection of cutting parameters – Design enhancements – Parametric – Approach only.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Idris Zehrudin Muhammed, Lean And Agile Manufacturing Systems ,VDM Verlag, First Edition2009.
2. Devadasan S R, Sivakumar V, Mohan Murugesh R and Shalij P R, Lean and Agile Manufacturing Theoretical Practical and Research Futurities, PHI,First ,Edition2012.

REFERENCE BOOKS:

1. Aruna Desai Lean Manufacturing: Perspectives and Applications (Operations Management Series) ICFAI University Press, First Edition2008.
2. John W Davis ,Implementing Lean Manufacturing: An Operations Managers Guide Industrial Press, New edition2009.
3. Gunasegaram A Agile Manufacturing. The 21st Century Competitive Strategy Elsevier, First Edition , 2001.
4. Goranson H T The Agile Virtual EnterpriseCases Metrics Tools Green Wood Publishing Group, First Edition1999
5. Lonnie Wilson How to Implement Lean Manufacturing McGraw-Hill, First Edition2009.

WEB URLs:

1. www.utsi.edu/events/thursdayhandouts.pdf.
2. www.accountingexplained.com/managerial/inventory-management/safety-stock
3. www.panview.nl/en/lean-production-toyota-3m-model/toyota-3m-model-muda-mura-muri
4. www.web1.fkm.utm.my/UserFiles/file/5sfkm/5S%20rev%20utm%20[Compatibility%20Mode].pdf
5. www.smartdraw.com/value-stream-map

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.8**	**1.8**	1	-	**1**	-	-	-	-	-	-	**1**	-	-

24BEMEXXXX	**PROFESSIONAL ELECTIVE COURSES: VERTICAL 4 HEATING VENTILATION AIR CONDITIONING AND REFRIGERATION SYSTEMS**	3H – 3C

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

PRE-REQUISITES: Thermal Engineering and Refrigeration and Air Conditioning

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To learn the basic concepts behind working of refrigeration system.
- To impart knowledge on fundamentals of psychrometric processes and air conditioning system
- To identify the various components of HVAC systems and perform heat load calculations

COURSE OUTCOMES:

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

CO1: explain the principles of thermodynamic states, heat transfer and refrigeration cycles K2
CO2: illustrate the significance of psychrometric properties and its applications K2
CO3: indicate the role of air-conditioning refrigerants and their maintenance practices. K2
CO4: apply the HVAC concepts in the human comfort K3
CO5: estimate cooling load and heating load considering human comfort in an air conditioning system K3

UNIT I REFRIGERATION SYSTEMS AND REFRIGERATION EQUIPMENT 9

Thermodynamic state of a pure substance - Modes of heat transfer laws of heat transfer - Mechanisms of Production of cold - Unit of Refrigeration - Types of Refrigeration - Reversed Carnot cycle - C.O.P of Heat Engine - Heat pump and Refrigerating Machine - Compressor - Condensers - Cooling towers - Expansion valve and Evaporators - Vapour Compression Refrigeration systems and Vapour Absorption Refrigeration systems.

UNIT II PSYCHROMETRICS 9

Psychrometry Properties - Adiabatic saturation of air by evaporation of water - Psychometric Chart and its uses - Sensible heating and cooling - Humidifying and Heating - Dehumidifying and Cooling- Adiabatic Cooling with Humidification - Total heating or cooling processes-Sensible heat factor - Bypass factor - Adiabatic mixing - Evaporative cooling - Problems on Psychrometric Charts.

UNIT III AIR CONDITIONING 9

Air-conditioning -Factors controlled in Air-Conditioning - Types: Window type AC - Split AC system and Package AC system - Refrigerants and Brine - Centralized AC plant -Direct Expansion System and Water-Cooled System - Centralized AC plant -Air handling units - Overload protector - Relay types, high pressure and low pressure cut out - Centralized AC plant - Lubrication Oil properties and types - Oil charging, leak testing methods and gas charging procedure - Maintenance procedure and general troubles in AC System

UNIT IV HVAC 9

Introduction to HVAC - Introduction to Codes & Standards - Heating Ventilation and Air -Conditioning: Codes and standards (ASHRAE, ISHRAE and IMC) - Ducts and its types - Duct fittings - Flexible ducts - Duct elbows selections -Vanes, dampers and their importance - Duct designing methods using Equal friction/Velocity reduction method - Pipe sizing methods - Chilled water pipe sizing - Pump size.

UNIT V HEAT LOAD CALCULATIONS 9

Heat Load Calculations- Equipment Selection - Air Distribution System - Ventilation & Exhaust Systems – Piping Static Pressure Calculations and Pump Head Calculation - Air Conditioning Concepts – Duct system - Distribution system - Adding and modifying fittings.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. P.L.Ballaney, Refrigeration and Air conditioning Khanna Publishers, Sixteenth Edition 2023
2. Domkundwar A ,Course in Refrigeration and Air conditioning Dhanpat Rai, First Edition 2018

REFERENCE BOOKS:

1. Spitler Mc Quiston Parker Heating, Ventilating and Air Conditioning: Analysis and Design Wiley India, Seventh Edition 2023.
2. V.K.Jain ,Refrigeration and Air conditioning Lakshmi Publications, First Edition 2019.
3. Roy J. Dossat ,Principles of Refrigeration Pearson Education, Fourth Edition 2002.
4. Arora C.P ,Refrigeration and Airconditioning Tata Mc Graw –Hill, Fourth Edition 2021.
5. Samuel C. Sugarman ,HVAC Fundamentals, Third Edition River Publishers, Third Edition 2023

WEB URLs:

1. www.ashrae.org
2. www.hvactechhangout.com
3. www.energy.gov/energysaver/air-conditioning

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.4**	**1.4**	1	-	**1**	-	-	-	-	-	-	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 4

24BEMEXXXX POWER PLANT ENGINEERING 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Thermal Engineering

COURSE OBJECTIVES:

The goal of this course is for the students to**:**

- To familiarize the layout of steam power plant and working of diesel and gas turbine power plant
- To understand the process flow of nuclear power plant
- To impart knowledge on renewable energy employed for energy generation and the environmental impact of power plant and their economics.

COURSE OUTCOMES:

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

CO1:	explain the working of steam power plant and its accessories	K3
CO2:	describe the working of Diesel and Gas Turbine power plants	K2
CO3:	elucidate the working of nuclear power plants and their design aspects	K2
CO4:	use renewable energy technologies for generating electricity	K3
CO5:	identify the cost controlling methods and environmental impact of power plants	K3

UNIT I COAL BASED THERMAL POWER PLANTS 9

Rankine cycle – Layout of steam power plant – Super critical boilers – FBC boilers – High Pressure fire tube boilers – Fuel and ash handling – Combustion equipment – Electrostatic precipitator -Mechanical stokers – Pulveriser – Draught System – Cooling towers.

UNIT II DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS 9

Otto, Diesel, Dual & Brayton Cycle — Analysis & Optimization. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems

UNIT III NUCLEAR POWER PLANTS 9

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors: Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium-Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

UNIT IV POWER FROM RENEWABLE ENERGY 9

Hydro Electric Power Plants — Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.

UNIT V ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS 9

Actual load curves – Cost of electric energy – Fixed costs and operating costs – Variable load operation – Energy rates – Types of tariffs – Economics of load sharing – Comparison of economics of various power plants.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Nag P K Power Plant Engineering Tata McGraw Hill, Fifth Edition 2021.
2. Rajput R K Power Plant Engineering Laxmi Publications, Fifth Edition 2016.

REFERENCE BOOKS:

1. Harish C Rai Power Plant Engineering I K International Publishing, First Edition 2011.
2. El-Wakil M M Power Plant Technology Tata McGraw Hill, First Edition 2011.
3. Morse Frederick T Power Plant Engineering Prentice Hall of India, Third Edition 2008
4. John Twidell and Tony Weir Renewable Energy Resources Taylor and Francis, Second Edition 2015.
5. Elanchezhian C Power Plant Engineering I K International Publishing,First Edition 2007

WEB URLs:

1. www.indianpowersector.com
2. www.world-nuclear.org
3. www.geothermaleducation.org

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.6**	**1.6**	1	-	**1**	-	-	-	-	-	-	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 4

24BEMEXXXX ENERGY MANAGEMENT 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Thermal Engineering

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To learn the importance of energy management and energy audit.
- To impart the knowledge about the energy efficiency and its utilization.
- To gain knowledge on energy management and its economics

COURSE OUTCOMES:

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

CO1:	make procedure for energy audit methods.	K2
CO2:	identify best energy utilization for better energy efficiency	K2
CO3:	recognize the demands in energy management .	K2
CO4:	classify energy management opportunities in industries	K3
CO5:	perform energy economics	K3

UNIT I ENERGY MANAGEMENT & ENERGY AUDIT 9

General principles of energy management and energy management planning - Energy Audit: Definition, need, types and methodologies - Instruments for energy audit, Energy audit report - Power quality audit - Energy conservation in buildings: ECBC code (basic aspects) - Building Management System (BMS).

UNIT II ENERGY EFFICIENCY IN ELECTRICITY UTILIZATION 9

Electricity transmission and distribution system - cascade efficiency - Lighting: Modern energy efficient light sources - life and efficacy comparison with older light sources - energy conservation in lighting - use of sensors and lighting automation - Motors: Development of energy efficient motors and the present status - techniques for improving energy efficiency - necessity for load matching and selection of motors for constant and variable loads - Transformers: Present maximum efficiency standards for power and distribution transformers - design measures for increasing efficiency in electrical system components

UNIT III DEMAND SIDE MANAGEMENT 9

Introduction to DSM, benefits of DSM, different techniques of DSM –time of day pricing, multi-utility power exchange model, time of day models for planning. Load management, load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment. Power factor improvement, numerical examples. DSM and Environment.

UNIT IV ENERGY MANAGEMENT IN INDUSTRIES 9

Boilers: working principle - blow down, energy conservation opportunities in boiler. Steam: properties of steam, distribution losses, steam trapping. Identifying opportunities for energy savings in steam distribution. Furnace: General fuel economy measures, energy conservation opportunities in furnaces. HVAC system: Performance and saving opportunities in Refrigeration and Air conditioning systems. Heat Recovery Systems: Waste heat recovery system - Energy saving opportunities. Cogeneration: Types and schemes, optimal operation of cogeneration plants, combined cycle electricity generation.

UNIT V ENERGY ECONOMICS 9

Economic analysis: methods, cash flow model, time value of money, evaluation of proposals, pay-back period, average rate of return method, internal rate of return method, present value method, life cycle costing approach. Computer aided Energy Management Systems (EMS).

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Barney L. Capehart Wayne C. Turner William J. Kennedy Guide To Energy Management River Publishers; Eighth edition2016.
2. Albert Thumann D. Paul Mehta Handbook of Energy Engineering River Publishers; Eighth edition,2021.

REFERENCE BOOKS:

2. Albert Thumann, William J. Younger ,Handbook of Energy Audits ,CRC Press,2003.
3. D. Yogi Goswami, Frank Kreith ,Energy Management and Conservation Handbook ,CRC Press2007.
4. Kankar Bhattacharya, Jaap E. Daadler, Math H.J Bollen ,Operation of restructured power systems, Kluwer Academic Publications2001.
5. Stephen A. Roosa, Steve Doty Wayne C. Turner, Energy management Hand Book River Publishers; Ninth edition2018.
6. Charles M. Gottschalk, Industrial energy conservation, John Wiley & Sons1996.

WEBSITES:

1. https://archive.nptel.ac.in/courses/108/106/108106022/
2. https://fenix.tecnico.ulisboa.pt/downloadFile/1689468335672878
3. https://www.ese.iitb.ac.in/~rb/Talks_Seminars/EnergyFutures15.pdf

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.4**	**1.4**	1	-	**1**	-	-	-	-	-	-	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 4

24BEMEXXXX THERMAL MANAGEMENT OF BATTERIES AND FUEL CELLS 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Thermal Engineering

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To study the function of different batteries.
- To impart knowledge on thermal distribution in battery and fuel cell.
- To learn the heat removal process in fuel cell and application.

COURSE OUTCOMES:

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

CO1:	categorize different types of batteries for engineering application	K2
CO2:	use PCM principles in battery thermal management.	K3
CO3:	identify fuel cells for different applications	K3
CO4:	discuss methods of cooling system for fuel cell	K3
CO5:	select economic fuel cell for different applications	K3

UNIT I BATTERY TECHNOLOGIES 9

Introduction - Current Battery Technologies - Lead Acid Batteries - Nickel Cadmium Batteries - Nickel Metal Hydride Batteries - Lithium-Ion Batteries - Battery Technologies under Development: Zinc-Air Batteries, Sodium-Air Batteries, Lithium-Sulfur Batteries, Aluminium-Air Batteries, Lithium-Air Batteries

UNIT II BATTERY THERMAL MANAGEMENT 9

EV Battery Cooling - Challenges and solutions - Heat Exchanger Design and Optimization Model for EV Batteries using PCMs - System set up - Selection of PCMs - Chevrolet Volt Model Battery Thermal Management System - Case study

UNIT III FUEL CELL TECHNOLOGIES 9

Introduction - Various types of fuel cell systems - Low temperature fuel cells - High temperature fuel cells - Fuel cell thermodynamics - Heat and work potentials in fuel cell - Prediction of reversible voltage in fuel cell - Fuel cell efficiency

UNIT IV FUEL CELL THERMAL MANAGEMENT 9

Balance of Plant Components - System Configuration and Sizing - Thermal Management and Water Management - Control and Power Management

UNIT V APPLICATION OF FUEL CELL AND ECONOMICS 9

Fuel cell usage for domestic power systems - large scale power generation: Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell - Future trends in fuel cells.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Ibrahim Dinner, Halil S. Hamut, and Nader Javani, Thermal Management of Electric Vehicle Battery Systems, Wiley2017.
2. Ma. J Battery Technologies: Materials and Components, Wiley, 2021.

REFERENCE BOOKS:

1. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi Modern Electric, Hybrid Electric, and Fuel Cell Vehicles-Fundamentals, Theory, and Design ,CRC Press,2005.
2. John G. Hayes and G. Abas Goodarzi Electric Powertrain, Wiley, 2018.

3. Davide Andrea Battery Management Systems for Large Lithium-Ion Battery Packs, ARTECH House, 2010.
4. Younes Shabany Heat Transfer: Thermal Management of Electronics, CRC Press, 2010.
5. T. Yomi Obidi Thermal Management in Automotive applications, SAE International, 2015.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.8**	**1.8**	1	-	**1**	-	-	-	-	-	-	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 4

24BEMEXXXX HYBRID AND ELECTRIC VEHICLES 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Thermal Engineering and Basic Electrical and Electronics Engineering

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To provide an overview on Electric and Hybrid Electric Vehicles
- To impart knowledge on hybrid drive trains and their propulsion unit
- To familiarize with energy storing units and strategies followed in energy management

COURSE OUTCOMES:

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

CO1: explain the modified components for hybrid and electric vehicles K2
CO2: describe the functions of hybrid and electric trains. K2
CO3: recognize the components required for electric propulsion unit K2
CO4: identify different energy storage devices K2
CO5: compare and chose best energy management strategies K3

UNIT I INTRODUCTION TO HYBRID ELECTRIC VEHICLES 9

History of hybrid and electric vehicles - Social and environmental importance of hybrid and electric vehicles - Impact of modern drivetrains on energy supplies - Conventional Vehicles: Basics of vehicle performance - Vehicle power source characterization - Transmission characteristics - Mathematical models to describe vehicle performance

UNIT II HYBRID AND ELECTRIC DRIVETRAINS 9

Hybrid Electric Drive-trains: Basic concept of hybrid traction - Introduction to various hybrid drive train topologies - Power flow control in hybrid drivetrain topologies - Fuel efficiency analysis - Electric drivetrains: Basic concept of electric traction - Introduction to various electric drivetrain topologies - power flow control in electric drivetrain topologies - Fuel efficiency analysis.

UNIT III ELECTRIC PROPULSION UNIT 9

Introduction to electric components used in hybrid and electric vehicles - Configuration and control of DC Motor drives - Configuration and control of Induction Motor drives - Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power

UNIT IV ENERGY STORAGE SYSTEM 9

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles - Battery based energy storage and its analysis - Fuel Cell based energy storage and its analysis - Hybridization of different energy storage devices

UNIT V ENERGY MANAGEMENT STRATEGIES 9

Introduction to energy management strategies used in hybrid and electric vehicles - Classification of different energy management strategies - Comparison of different energy management strategies

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Iqbal Hussein ,Electric and Hybrid Vehicles: Design Fundamentals, CRC Press,2003.
2. Ma. J Battery Technologies: Materials and Components Wiley,2021.

REFERENCE BOOKS:

1. James Larminie John Lowry Electric Vehicle Technology Explained, Wiley CRC Press,2005.
2. John G. Hayes and G. Abas Goodarzi ,Electric Powertrain ,Wiley,2018.
3. Mehrdad Ehsani YimiGao Ali Emadi Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design Routledge, Third Edition, 2018.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.2**	**1.2**	1	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**

OFESSIONAL ELECTIVE COURSES: VERTICAL 4

24BEMEXXXX AUTOMOTIVE MATERIALS, COMPONENTS, DESIGN AND TESTING 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Thermal Engineering and Engineering Materials and Metallurgy

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To study the functional requirements of engine components and suitable materials
- To learn the procedure to design various engine components
- To study the performance measurement technologies of and engine

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Discuss the requirements of engine components and select suitable materials K2

CO2: design to cylinder and piston components and solve problems K3

CO3: Design Connecting rod and crank shaft and solve problems K3

CO4: Design to flywheel and valve train and solve problems K3

CO5: Discuss engine tested cycles and measurement technologies K3

UNIT – I FUNCTIONAL REQUIREMENTS OF ENGINE COMPONENTS 9

Functional requirements of engine components — Piston, piston pin, cylinder liner, connecting rod, crank shaft, valves, spring, engine block, cylinder head, and flywheel. Suitable materials for engine components.

UNIT – II DESIGN OF CYLINDER AND PISTON COMPONENTS 9

Design of cylinder, cylinder head, piston, piston rings and piston pin – more details in necessary

UNIT – III DESIGN OF CONNECTING ROD AND CRANK SHAFT 9

Design of connecting rod – Shank design – small end design – big end design – bolts design. Design of overhangcrank shaft under bending and twisting – Crank pin design – Crank web design – Shaft design.

UNIT – IV DESIGN OF FLYWHEEL AND VALVE TRAIN 9

Design of valve – inlet valve – exhaust valve - Valve springs – tappet – rocker arm. Determination of mass of flywheel for a given coefficient of fluctuation of speed. Design of flywheel - rim - hub - arm.

UNIT – V ENGINE TESTING 9

Engine test cycles – WLTC – WHSC – WHVC – NRTC – ISO 8178. Dynamometer - Chassis dynamometer - transient dynamometer. Emission measurement technologies and instruments - NOX – Smoke – Particulate matter – CO – CO2 - HC.-Particle counters

TOTAL=45 PERIODS

TEXT BOOKS:

1. 1.Khurmi. R.S. & Gupta. J.K., "A text book of Machine Design", Eurasia Publishing House (Pvt) Ltd, 2001.

2. The Automotive Chassis: Volume 1: Components Design (Mechanical Engineering Series) byGiancarlo Genta and Lorenzo Morello | 24 December 2019.

REFERENCES:

1 Jain.R.K, “Machine Design”, Khanna Publishers, New Delhi, 2005.
2. Manufacturing Automotive Components from Sustainable Natural Fiber Composites (SpringerBriefs in Materials) by Lobna A. Elseify, Mohamad Midani, et al. | 9 August 2021
3. Mechanical and Materials Engineering of Modern Structure and Component Design (Advanced Structured Materials Book 70) by Andreas Öchsner and Holm Altenbach | 6 June 2015.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.8**	**1.8**	1	-	**1**	-	-	-	-	-	-	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 5

24BEMEXXXX NON DESTRUCTIVE TESTING 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Metrology and measurements, Engineering materials and metallurgy

COURSE OBJECTIVES:

The goal of this course is for the students to**:**

- To impart knowledge on various NDT methods
- To learn the techniques to detect defects in components
- To study on the methods adopted in NDT

COURSE OUTCOMES:

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

CO1:	Classify various non-destructive testing methods.	K2
CO2:	Explain the principles of equipment's used fi testing the surfaces	K2
CO3:	Identify defects using relevant thermography and eddy current methods	K3
CO4:	Illustrate the working of ultrasonic and acoustic testing methods	K2
CO5:	Demonstrate the radiography testing methods	K2

UNIT I OVERVIEW OF NDT 9

NDT Versus Mechanical testing, Overview of the Non-Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT. Visual inspection – Unaided and aided.

UNIT II SURFACE NDT METHODS 9

Liquid Penetrant Testing – Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results - Magnetic Particle Testing - Theory of magnetism, inspection materials, magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism

UNIT III THERMOGRAPHY AND EDDY CURRENT TESTING (ET) 9

Thermography - Principles, Contact and non -contact inspection methods, Techniques for applying liquid crystals, Advantages, and limitation – Infrared radiation and infrared detectors, Instrumentations and methods, applications - Eddy Current Testing - Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

UNIT IV ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE) 9

Ultrasonic Testing - Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan - Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique – Principle, AE parameters, Applications.

UNIT V RADIOGRAPHY (RT) 9

Radiography Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films – graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu Practical Non-Destructive Testing Narosa Publishing House, 2009.
2. Vernon John Non-Destructive Testing Springer Verlag,2015.

REFERENCE BOOKS:

1. Ravi PrakashNon-Destructive Testing Techniques, New Academic Science,2009.
2. Giuseppe Lacidogna Non-Destructive Testing ,MDPI,2021.
3. Dr. M. Adithan Non Destructive Testing Khanna Publishers, First Edition,2021.
4. Charles J. Hellier Handbook of Nondestructive Evaluation McGraw-Hill Education, Third Edition,2020.
5. Lari & Kumar Basics of Non-Destructive Testing S.K. Kataria & Sons,2021.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.2**	**1.2**	1	-	**1**	-	-	-	-	-	-	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 5

24BEMEXXXX HYDRAULICS AND PNEUMATICS 3H – 3C

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

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to**:**

- To learn the basic principles of fluid power and their systems
- To acquire knowledge of various components used in hydraulic systems
- To design hydraulic systems for specific applications

COURSE OUTCOMES:

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

CO1:	recognize symbols and explain the importance of hydraulics systems	K2
CO2:	Explain the working and applications of hydraulic pumps	K2
CO3:	Illustrate the working and applications of hydraulic actuators	K2
CO4:	Discuss the components in a hydraulic system	K2
CO5:	Develop hydraulic circuits for the given application	K3

UNIT I INTRODUCTION TO FLUID POWER SYSTEMS 9

Introduction to fluid power, advantages of fluid power, application of fluid power system – Types of fluid power systems – Properties of hydraulic fluids – General types of fluids –Fluid power symbols – Basics of Hydraulics – Applications of Pascals Law – Laminar and Turbulent flow – Reynold's number – Darcy's equation – Losses in pipe, valves and fittings.

UNIT II SOURCES OF HYDRAULIC POWER 9

Principle of operation of hydraulic machines – Pumping theory – Pump classification – Gear pump, vane Pump, piston pump, construction and working of pumps – Pump performance – Variable displacement pumps – Pump characteristics and system design.

UNIT III HYDRAULIC ACTUATORS 9

Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, Double acting special cylinders like tanden, rodless, telescopic, cushioning mechanism – Construction of double acting cylinder – Rotary actuators – Fluid motors, gear, vane and piston motors.

UNIT IV CONSTRUCTION OF CONTROL COMPONENTS 9

Directional control valve – 3/2-way valve – 4/2-way valve – Shuttle valve – Check valve – Pressure control valve – Pressure reducing valve – Sequence valve – Flow control valve – Fixed and adjustable – Electrical control solenoid valves – Relays – Ladder diagram.

UNIT V DESIGN OF HYDRAULIC CIRCUITS 9

Accumulators and Intensifiers: Types of accumulators – Accumulators circuits, sizing of accumulators, intensifier – Applications of Intensifier – Intensifier circuit – Servo systems – Hydro mechanical servo systems – Electro hydraulic servo systems and proportional valves – Fluidics – Introduction to fluidic devices, simple circuits.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Andrew Parr, "Hydraulics and Pneumatics: A Technician's and Engineer's Guide", 3rd Edition, Elsevier, 2023.
2. Anthony Esposito, Fluid Power with Applications, 7th edition, Pearson, 2018.

REFERENCE BOOKS:

1. Medhat Khalil, "Hydraulic Systems, Modeling and Simulation for Application Engineers", 1st Edition, CompuDraulic LLC, 2020.
2. Srinivasan R, "Hydraulic and Pneumatic controls", 3rd Edition, Vijay Nicole, 2019.
3. Qin Zhang, "Basics of hydraulic systems", 2nd Edition, CRC Press, 2019.
4. Shanmuga sundaram K, "Hydraulics and Pneumatics Controls", 3rd Edition, S Chand, 2018.
5. Md. Abdus Salam, "Fundamentals of Pneumatics and Hydraulics," 1st Edition, Springer Nature, 2022.

WEB URLs:

1. https://www.usb.ac.ir/FileStaff/4318_2019-6-6-12-29-14.pdf –
2. https://www.elearn.nptel.ac.in/shop/nptel/hydraulic-engineering/
3. https://www.archive.nptel.ac.in/courses/112/105/112105047/

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.2**	**1.2**	1	-	**1**	-	-	-	-	-	-	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 5

24BEMEXXXX GAS DYNAMICS AND JET PROPULSION 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Engineering thermodynamics, Heat and mass transfer

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To study the concept of a compressible flow through ducts
- To learn the shock wave and the variation of flow properties across the shock wave
- To identify the various types of aircraft and rocket propulsion systems

COURSE OUTCOMES:

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

CO1: Apply the fundamentals of compressible flow concepts and the use of gas tables. K3
CO2: Evaluate the compressible flow behaviour in constant area ducts. K3
CO3: Calculate the shock waves and explain its effects. K3
CO4: Explain the types of jet propulsion and their performance parameters K2
CO5: Discuss the rocket propulsion system and its characteristics K2

UNIT – I BASIC CONCEPTS AND ISENTROPIC FLOWS 9

Energy and momentum equations of compressible fluid flows, Concepts of compressible flow – Mach waves and Mach cone. Flow regimes, effect of Mach number on compressibility. Stagnation, static, critical properties and their interrelationship. Isentropic flow and its relations. Isentropic flow through variable area ducts – nozzles and diffusers. Use of Gas tables.

UNIT – II COMPRESSIBLE FLOW THROUGH DUCTS 9

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties. Choking. Isothermal flow with friction.

UNIT – III NORMAL AND OBLIQUE SHOCKS 9

Governing equations - Rankine-Hugoniot Relation. Variation of flow parameters across the normal and oblique shocks. Prandtl – Meyer expansion and relation.

UNIT – IV JET PROPULSION 9

Theory of jet propulsion – thrust equation – Performance parameters - thrust, power and efficiency. Operation, cycle analysis and performance of ram jet, turbojet, turbofan, turbo prop and pulse jet engines.

UNIT – V SPACE PROPULSION 9

Types of rocket engines and propellants. Characteristic velocity – thrust equation. Theory of single and multistage rocket propulsion. Liquid fuel feeding systems. Solid propellant geometries. Orbital and escape velocity. Rocket performance calculations.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Anderson, J.D ,Modern Compressible flow McGraw Hill, Third Edition,2003.
2. S.M. Yahya, Fundamentals of Compressible Flow with Aircraft and Rocket propulsion, New Age International (P) Limited, Fourth Edition,2012.

REFERENCE BOOKS:

1. R. D. Zucker O Biblarz, Fundamentals of Gas Dynamics ,Wiley2011.
2. Balachandran, P ,Fundamentals of Compressible Fluid Dynamics ,PHI Learning,2007.
3. Radhakrishnan, E. ,Gas Dynamics PHI Learning,2006.
4. Hill and Peterson Mechanics and Thermodynamics of Propulsion Addison , Wesley,1965.
5. Babu, V Fundamentals of Compressible Flow CRC Press, First Edition,2008.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.6**	**1.6**	1	-	**1**	-	-	-	-	-	-	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 5

24BEMEXXXX **AIRCRAFT SYSTEMS** **3H – 3C**

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

End Semester Exam: 3 Hours

PRE-REQUISITES : Engineering mechanics,

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To learn about the history of flight and the current trends in the aircraft industry.
- To recognize the various types of aircrafts according to its design and configuration.
- To study about the basic principles involved in flight and their mechanics.

COURSE OUTCOMES:

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

CO1: identify the basic steps involved in construction of an aircraft. K2
CO2: compare the various types of aircrafts based on its design and configuration. K2
CO3: explain the knowledge of various types of aircraft systems. K2
CO4: outline the knowledge of basics principles of flight based on aerodynamics. K2
CO5: summarize the basics of flight mechanics. K2

UNIT I AIRCRAFT INDUSTRY OVERVIEW 9

Evolution and history of flight – Types of aerospace industry – Key players in aerospace industry – Aerospace manufacturing – Industry supply chain – Prime contractors – Tier 1 suppliers – Key challenges in Industry supply chain – OEM supply chain strategies – Mergers and acquisitions – Aerospace industry trends – Advances in engineering/CAD/CAM/CAE tools and materials technology – Global and Indian aircraft scenario.

UNIT II AIRCRAFT COMPONENTS AND CONFIGURATIONS 9

Basic components of an aircraft – Structural members – Aircraft axis system – Aircraft motions – Control surfaces and high lift devices – Types of aircrafts – Lighter than air/heavier than air – Aircrafts conventional design configurations based on power plant location – Wing vertical location – Intake location – Tail unit arrangements – Landing gear arrangements – Unconventional configurations – Biplane ,Variable sweep, Canard layout, Twin boom layouts, Span loaders, Blended body wing layout, STOL and STOVL aircraft, Stealth aircraft – Advantages and disadvantages of these configurations

UNIT III AIRCRAFT SYSTEMS 9

Types of aircraft systems – Mechanical systems, electrical and electronic systems – Auxiliary systems – Mechanical Systems – Environmental control systems (ECS) – Pneumatic systems – Hydraulic systems – Fuel systems – Landing gear systems – Engine control systems – Ice and rain protection systems – Cabin pressurization and air conditioning systems – Steering and brakes systems auxiliary power unit – Electrical systems: Avionics – Flight controls – Autopilot and flight management systems – Navigation systems – Communication – Information systems – Radar system

UNIT IV FLIGHT MECHANICS 9

Significance of speed of sound – Air speed and ground speed – Properties of atmosphere – Bernoulli's equation – Forces on the airplane – Airflow over wing section – Pressure distribution over a wing section – Generation of lift – Drag – Pitching moments – Types of drag – Lift curve – Drag curve – Lift/drag ratio curve – Factors affecting lift and drag – Center of pressure and its effects – Aero foil nomenclature – Types of aero foil – Wing section – Aerodynamic center – Aspect ratio – Effects of lift, Drag, Speed, Air density on drag

UNIT V FLIGHT DYNAMICS **9**

Mach waves – Mach angles – Sonic and supersonic flight and its effects stability and control – Degree of Stability – Lateral – Longitudinal and directional stability and controls of aircraft – Effects of flaps and slats on lift coefficients – Control tabs – Stalling – Landing – Gliding, Turning – Speed of sound – Mach numbers – Shock waves – Aircraft Performance and Maneuvers –Power curves – Maximum and minimum speeds of horizontal flight – Effects of changes of engine power – Effects of altitude on power curves – Forces acting on an aero plane during a turn – Loads during a turn – Correct and incorrect angles of bank – Aerobatics – Inverted maneuvres – Maneuvrability.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Kermode A C "Flight without Formulae" Pearson Education, Fifth Edition, 2004
2. Kermode A C "Mechanics of Flight" PHI, Eleventh Edition, 2007.

REFERENCE BOOKS:

1. Shevell S R "Fundamentals of Flight", Pearson Education, Second Edition, 2004.
2. John David Anderson, "Introduction to Flight" McGraw Hill Higher Education, Ninth Edition, 2022.
3. Ian Moir Allan Seabridge "Aircraft Systems Mechanical Electrical and Avionics Subsystems Integration" John Wiley and Sons, Third Edition 2008.
4. Barnard R H, Philpott D R "Aircraft Flight: A Description of the Physical Principles of Aircraft Flight" Prentice Hall, Fourth Edition 2010.
5. Chris Binns, "Aircraft Systems: Instruments, Communications, Navigation and Control," Wiley, First Edition 2023.

WEB URLs:

1. http://home.iitk.ac.in/~mohite/Basic_components_functions.pdf
2. www.aeronautics.nasa.gov/pdf/axes_control_surfaces_5-8.pdf
3. www.aviation–history.com/video.html

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx	2	1	-	-	**1**	-	-	-	-	-	-	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 5

24BEMEXXXX COMPOSITE MATERIALS AND MECHANICS 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Engineering materials and metallurgy

COURSE OBJECTIVES:

The goal of this course is for the students to:

- To study the fundamentals of composite material
- To study the thermal and mechanical behavior of composites
- To provide an understanding industrial applications of composite materials

COURSE OUTCOMES:

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

CO1: Summarize the various types of fibers, manufacturing methods. K2
CO2: Derive equation s of flat plate Laminate structures K3
CO3: Estimate the strength of laminate composites K3
CO4: Solve problems on the thermal behaviour of Composite laminates K3
CO5: Study the parameters influencing the laminate flat plates. K3

UNIT – I INTRODUCTION 9

Definition –Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramics and Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina –Transformation Matrix, Transformed Stiffness. Manufacturing: Bag Moulding Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes .

UNIT – II FLAT PLATE LAMINATE CONSTITUTE EQUATIONS 9

Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

UNIT – III LAMINA STRENGTH ANALYSIS 9

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure

UNIT – IV THERMAL ANALYSIS 9

Assumption of Constant C.T. E's. Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T. E's. C.T. E's for special Laminate Configurations –Unidirectional, Off axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates .

UNIT – V ANALYSIS OF LAMINATED FLAT PLATES 9

Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Gibson, R.F .Principles of Composite Material Mechanics .McGraw-Hill, Second Edition1994.
2. Hyer, M.W. Stress Analysis of Fiber – Reinforced Composite Materials . McGraw Hill1.1998.

REFERENCE BOOKS:

1. Agarwal, B.D., Broutman L.J ,Analysis and Performance of Fiber Composites, John Wiley and Sons,1990.
2. Halpin, J.C, Primer on Composite Materials, Analysis ,Technomic Publishing Co. 1984.
3. Issac M. Daniel Ori Ishai Engineering Mechanics of Composite Materials, Oxford University Press, First Edition2007.
4. Mallick, P.K., Fiber Reinforced Composites: Materials, Manufacturing and Design Maneel Dekker Inc,1993.
5. Mallick, P.K. and Newman, S Composite Materials Technology: Processes and Properties Hansen Publisher,1990.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.8**	**1.8**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**

PROFESSIONAL ELECTIVE COURSES: VERTICAL 5

24BEMEXXXX **COMPUTATIONAL FLUID DYNAMICS** **3H – 3C**

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

End Semester Exam: 3 Hours

PRE-REQUISITES : Finite element analysis

COURSE OBJECTIVES:

The goal of this course is for the students to

- Equip students with the knowledge base essential for application of computational fluid dynamics to engineering flow problems
- To Formulate diffusion –convection problems using finite volume method
- To study the flow field and turbulence modeling

COURSE OUTCOMES:

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

CO1:	explain the fundamentals of CFD, and develop case specific governing equations.	**K3**
CO2:	summarize the finite difference and finite volume based analysis for steady and transient diffusion problems.	**K2**
CO3:	utilize the various mathematical schemes under finite volume method for convention diffusion.	**K3**
CO4:	solve complex problems in the field of fluid flow and heat transfer with the support of high speed computers.	**K3**
CO5:	apply the various discretization methods, solution procedure and the concept of turbulence modelling.	**K3**

UNIT – I INTRODUCTION **9**

Basics of Computational Fluid Dynamics – Governing equations– Continuity, Momentum and Energy equations – Boundary conditions & Types– Time-averaged equations for Turbulent Flow – Classification and Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations, comparison between Analytical, Experimental and Numerical techniques, Techniques of Discretization and Numerical errors

UNIT – II FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION **9**

Derivation of finite difference equations– General Methods for first and second order accuracy – Finite volume formulation for steady and transient diffusion 1D and 2D problems – Use of Finite Difference and Finite Volume methods, Accuracy of solution, optimum step-size, Euler, Crank-Nickolson, and pure implicit methods, stability of schemes.

UNIT – III FINITE VOLUME METHOD FOR CONVECTION DIFFUSION **9**

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes, properties of discretization schemes, Hybrid, Power-law, QUICK Schemes, Computation of Boundary layer flow, von Neumann stability analysis.

UNIT – IV FLOW FIELD ANALYSIS **9**

Stream function and vorticity, Representation of the pressure gradient term, Staggered grid – Momentum equations, Pressure and Velocity corrections – Pressure Correction equation, Simple algorithm, and its variants – PISO Algorithms, Computation of internal and external thermal boundary layer.

UNIT – V TURBULENCE MODELLING 9

Turbulence model requirement and types, mixing length model, Two equation (k-Є) models – High and low Reynolds number models, LES, DNS, Mesh Generation and refinement Techniques-software tools, Stability of solver, Courant Fredrick Levy number, relaxation factor, and grid independence test.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Versteeg, H.K. Malalasekera, W" An Introduction to Computational Fluid Dynamic: The finite volume Method." Pearson Education, 2014

2. Ghoshdastidar, P.S" Computational Fluid Dynamics and Heat Transfer" Cengage Learning,2017

REFERENCE BOOKS:

1. John. F. Wendt" Computational Fluid Dynamics – An Introduction", Springer,2013.

2. K. Muralidhar ,T.Sundararajan "Computational Fluid Flow and Heat Transfer, Narosa Publishing House, 1994.

3. Suhas V, Patankar "Numerical Heat transfer and Fluid flow" Taylor & Francis, 2009

4. Uriel Frisch, "Turbulence" Cambridge University Press, 1999

5. Yogesh Jaluria, Kenneth E. Torrance" Computational Heat Transfer", CRC

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.8**	**1.8**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**

PROFESSIONAL ELECTIVE COURSES: VERTICAL 5

24BEMEXXXX **DRONE TECHNOLOGY** **3H – 3C**

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

End Semester Exam: 3 Hours

PRE-REQUISITES : Engineering mechanics, Basics of Electrical and Electronics Engineering

COURSE OBJECTIVES:

The goal of this course is for the students to

- To learn the basic terminology of drone technology
- To impart knowledge of drone manufacturing procedures and its operation
- To gain knowledge in application of drone and its safety guidelines

COURSE OUTCOMES:

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

CO1: discuss on evolution of drone K2

CO2: explain about a various type of drone technology, drone fabrication and Programming K3

CO3: recommend appropriate sensors and actuators for drones K3

CO4: identify drone mechanism for specific applications K3

CO5: write programs for various drones K3

UNIT – I INTRODUCTION TO DRONE TECHNOLOGY 9

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the business- Drone business through entrepreneurship- opportunities/applications for entrepreneurship and employability

UNIT – II DRONE DESIGN, FABRICATION AND PROGRAMMING 9

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts - Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT – III DRONE FLYING AND OPERATION 9

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment - Drone controls Flight operations –management tool –sensors- on board storage capacity - Removable storage devices- Linked mobile devices and applications

UNIT – IV COMMERCIAL APPLICATIONS OF DRONES 9

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT – V FUTURE DRONES AND SAFETY 9

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Ralph DeFrangesco Stephanie DeFrangesco “The Big Book of Drones” CRC Press, 2022.

2. Terry Kilby and Belinda Kilby “Make: Getting Started with Drones” Maker Media, Inc, 2016.

REFERENCE BOOKS:

1. Chandra Singh Rathishchandra Ramachandra Gatti “Drone Applications for Industry 5.0” IGI Global,2024.

2. Sachi Nandan Mohanty,J.V.R.Ravindra, G.Surya Narayana,Chinmaya Ranjan Pattnaik and Y.Mohamed Sirajudeen“Drone Technology: Future Trends and Practical Applications” Wiley India,

2023.
3. Daniel Tal John Altschuld" Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation" John Wiley & Sons, Inc, 2021.
4. Zavrsnik "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018.
5. Fahlstrom, "Introduction To UAV Systems", Wiley India, Fourth Edition, 2022.

WEBSITES

1. https://www.unmannedsystemstechnology.com/
2. https://oscarliang.com/
3.https://feedly.com/i/top/drones-blogs

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.8**	**1.8**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**

OFESSIONAL ELECTIVE COURSES: VERTICAL 6

24BEMEXXXX **SUPPLY CHAIN MANAGEMENT** **3H – 3C**

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Nil

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Explore supply chain management concepts and their objectives
- Study the inventory management principles and forecasting methods in supply chain operations.
- To acquire knowledge on the supply chain management practices followed globally

COURSE OUTCOMES:

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

CO1: Explain the concepts of supply chain management K2
CO2: Select inventory management strategies to minimize costs. K3
CO3: Utilize information and technology for supply chain integration. K3
CO4: Develop strategic alliances to enhance procurement, distribution, and outsourcing. K3
CO5: Suggest supply chain management for global operations. K3

UNIT I INTRODUCTION TO SUPPLY CHAIN MANAGEMENT 9

Definition, global optimization, Objectives of SCM. Logistics networks– data collection, model and data elevation, solution techniques.

UNIT II INVENTORY MANAGEMENT 9

Introduction, single warehouse, Inventory examples, economic lot size model, effect of demand uncertainty. Risk pooling, centralized and decentralized system, managing inventory in the supply chain, forecasting.

UNIT III VALUE OF INFORMATION 9

Bullwhip effect, information and supply chain technology. Supply chain integration– push, pull and push– pull system. Demand driven strategies, impact of internet on SCM, distribution strategies.

UNIT IV STRATEGIC ALLIANCES 9

Framework for strategic alliance, third party logistics, retailer, supplies partnership, distributor– integration, procurement and out servicing strategies.

UNIT V INTERNATIONAL ISSUES IN SCM 9

Introduction, risks and advantages– design for logistics, supplies integration into to new product development, mass customization. Issues in customer value. Information technology for SCM: Goals, standardization, infrastructure.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Simchi – Levi David, Kaminsky Philip and Simchi–Levi Edith, Designing and Managing the SupplyChain, 3rd edition, Tata M.Graw– Hill Publishing Company Ltd, New Delhi, 2007.
2. Sunil Chopra and Peter Meindl, Supply Chain Management – Strategy, Planning and Operation,

2nd edition, Prentice Hall, New Delhi, 2005.

REFERENCE BOOKS:

1. Ayers J.B, Hand book of Supply Chain Management, 1st edition, The St. Lenciepress, New York, 2000.
2. Raghuram G and Rangaraj N, Logistics and Supply Chain Management: Cases and Concepts, 2nd edition,Macmillan, New Delhi, 2009.

WEBSITES:

1. https://old.mu.ac.in/wp-content/uploads/2021/02/Logistics-and-Supply-Chain-Management-Martin- Christopher.pdf
2. https://ebooks.lpude.in/management/mba/term_4/dmgt523_logistics_and_supply_chain_management.pdf

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	**2.8**	**1.8**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**

PROFESSIONAL ELECTIVE COURSES: VERTICAL 6

24BEMEXXXX PROCESS PLANNING AND COST ESTIMATION 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Nil

COURSE OBJECTIVE:

The goal of this course is for the students to

- To study the process planning concepts ant its applications
- To impart knowledge on the process and sequence of operations to obtain a final product
- To introduce the process planning concepts to make cost estimation

COURSE OUTCOMES:

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

CO1: Select the process, equipment and tools for various industrial products. K3
CO2: Prepare process planning activity chart. K3
CO3: Classify, explain and calculate the different costs K3
CO4: Calculate the cost involved in manufacturing K3
CO5: Evaluate the machining time for various machining operations. K3

UNIT I INTRODUCTION TO PROCESS PLANNING 9

Introduction- methods of process planning-Drawing interpretation-Material evaluation – steps in process selection-.Production equipment and tooling selection.

UNIT II PROCESS PLANNING ACTIVITIES 9

Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods - Set of documents for process planning-Economics of process planning- case studies.

UNIT III INTRODUCTION TO COST ESTIMATION 9

Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure- Estimation labor cost, material cost- allocation of overhead charges-Calculation of depreciation cost

UNIT IV PRODUCTION COST ESTIMATION 9

Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop .

UNIT V MACHINING TIME CALCULATION 9

Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations ,Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Peter scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technology Books, Dec 2002.
2. Sinha B.P, “Mechanical Estimating and Costing”, Tata-McGraw Hill publishing co, 1995.

REFERENCES BOOKS:

1. Chitale A.V. and Gupta R.C., "Product Design and Manufacturing", 2nd Edition, PHI, 2002.
2. Ostwalal P.F. and Munez J., "Manufacturing Processes and systems", 9 th Edition, John Wiley, 1998.
3. Russell R.S and Tailor B.W, "Operations Management", 4th Edition, PHI, 2003.
4. Mikell P. Groover, "Automation, Production, Systems and Computer Integrated Manufacturing", Pearson Education 2001.
5. K.C. Jain & L.N. Aggarwal, "Production Planning Control and Industrial Management", Khanna Publishers 199

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	3	2	1	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**

PROFESSIONAL ELECTIVE COURSES: VERTICAL 6

24BEMEXXXX TOTAL QUALITY MANAGEMENT 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Nil

COURSE OBJECTIVES:

The goal of this course is for the students to

- To acquire knowledge on using fundamentals of TQM and its importance
- To study the various tools of Total Quality Management
- To impart knowledge on the quality standards

COURSE OUTCOMES:

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

CO1:	Explain the importance of Total Quality Management	K2
CO2:	Illustrate the quality concepts and evolution of Total Quality Management	K2
CO3:	Summarize the tools involved in TQM	K2
CO4:	Discuss on the digital tools involved in TQM	K3
CO5:	Explain the ISO quality standards	K2

UNIT I INTRODUCTION TO TOTAL QUALITY MANAGEMENT 9

Introduction – Dimensions of quality – Quality planning – Quality costs – Analysis techniques for quality costs – Optimum quality costs – Basic concepts of TQM – Contributions of Deming – Juran and Crosby – Quality council, Statements and Circles – Strategic planning – Implementation of TQM – Barriers to TQM implementation.

UNIT II TQM PRINCIPLES 9

Leadership – Customer satisfaction, complaints and retention – Service quality – Employee involvement – Motivation – Empowerment – Teams recognition and reward – Performance appraisal – Continuous process improvement – PDSA Cycle – 5S, Kaizen, Kanban – Supplier partnership – Partnering, sourcing, supplier selection, supplier rating.

UNIT III TQM TOOLS AND TECHNIQUES I 9

The seven tools of quality – New seven management tools – Six sigma: Concepts, Methodology, application to manufacturing, service sector including IT – Bench marking, reason and process – FMEA – Stages, types.

UNIT IV TQM TOOLS AND TECHNIQUES II 9

Digital TQM – Quality Function Deployment (QFD) – House of quality – QFD process, benefits – Taguchi quality loss function –Total Productive Maintenance (TPM) – Concepts, improvements needs – Performance measure.

UNIT V QUALITY SYSTEMS 9

ISO Registration – Requirements – Implementation – ISO 9000 Standards – ISO 9001:2015 quality management system – ISO 27001:2022 Information security, Cyber security – ISO 19011:2018 Documentation – Quality auditing – ISO 14000 Environmental management systems – Concept, requirements and benefits.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Dale Besterfield H T, "Total Quality Management", 5th Edition, Pearson Education, 2018.
2. Poornima Charantimath M, "Total Quality Management", 4th Edition, Pearson Education, 2022.

REFERENCE BOOKS:

1. Feigenbaum A V, "Total Quality Control", 4th Edition, McGraw Hill, 2018.
2. Naagarazan R S, "Total Quality Management", 3rd Edition, New Age International, 2018.
3. James Evans R and William Lidsay M, "Managing for Quality and Performance Excellence" 11th Edition, Cengage Learning, 2019.
4. Jens Dahlgaard J, Ghopal Kanji K and Kai Kristensen, "Fundamentals of Total Quality Management", 1st Edition, Routledge, 2018.
5. Sunil Luthra, Dixit Garg, Ashish Agarwal and Sachin Mangla K, " Total Quality Management", 1st Edition, CRC Press, 2021.

WEB URLs:

1. https://www.wiley.com/college/sc/reid/chap5.pd
2. https://www.admin.umt.edu.pk/Media/Site/STD1/FileManager/OsamaArticle/sep7/om_10_leadership_management.pdf
3. https://www.pure.rug.nl/ws/portalfiles/portal/10216022/c2.pdf

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx	2.2	1.2	1	-	**1**	-	-	-	-	-	-	**1**	-	-

PROFESSIONAL ELECTIVE COURSES: VERTICAL 6

24BEMEXXXX ENTREPRENEURSHIP DEVELOPMENT 3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Nil

COURSE OBJECTIVES:

The goal of this course is for the students

- To acquire knowledge on the entrepreneurial skills and its importance
- To learn the strategies for developing a small business
- To develop the learner's entrepreneurial competencies in managing business

COURSE OUTCOMES:

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

CO1:	Outline the entrepreneurial competence to run the business efficiently	K2
CO2:	Explain the various environmental factors influencing and managing business organization	K2
CO3:	Construct the business plan based on comprehensive knowledge	K2
CO4:	Interpret the feasibility of business projects pertaining to various functional areas	K2
CO5:	Comment on the management strategies in developing a small business	K3

UNIT I ENTREPRENEURAL COMPETENCE 9

Entrepreneurship concept – Characteristics of successful entrepreneurs – Entrepreneurial personality – Knowledge and skills of an entrepreneur – Opportunities and government schemes to help startups – Entrepreneurship as a Career.

UNIT II ENTREPRENEURAL ENVIRONMENT 9

Business environment – Role of family and society – Entrepreneurship development training and other support – Organizational services – Basic laws in India to startups – Promotional policy and incentives from the Government.

UNIT III BUSINESS PLAN PREPARATION 9

Sources of product for business – Feasibility study – Criteria for selection of product – Ownership – Capital budgeting – Project profile preparation – Matching entrepreneur with the project – Identifying and selecting a product.

UNIT IV LAUNCHING OF SMALL BUSINESS 9

Small enterprises – Definition – Finance and human resource – Mobilization – Operations planning Market and channel selection – Growth strategies – Product launching – Incubation – Venturecapital– Start-ups.

UNIT V MANAGEMENT OF SMALL BUSINESS 9

Monitoring and evaluation of business – Business sickness – Prevention and rehabilitation of business units – Effective management of small business – Plant location – Plant layout – Work study – Motion study – CPM and PERT.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Hisrich R D, "Entrepreneurship", 8th Edition, McGraw Hill, 2018.
2. Amit Kumar Dwivedi, "Industrial Project and Entrepreneurship Development (WBSCTE)", 1st Edition, Vikas, 2018.

REFERENCE BOOKS:

1. Tripathi R S, Adarsh Tripathi and Ravi Kumar, **"**Industrial Management and Enterpreneurship Development", 1st Edition, NanoEdge Publication, 2018.
2. Priyadharshini M, Janani S, Sujeetha T N and Asokhan M, "A Textbook on Entrepreneurship Development and Management in Extension", 1st Edition, Write and Print Publications, 2018.
3. Prasanna Chandra, "Projects – Planning, Analysis, Selection, Implementation and Reviews", 8th Edition, McGraw Hill, 2019.
4. Khanka S S, "Entrepreneurial Development", 4th Edition, S Chand, 2020.

WEB URLs:

1. https://www.msme.gov.in/entrepreneurship-and-skill-development-programs
2. https://www.ncert.nic.in/ncerts/l/lebs213.pdf
3. https://www.ddceutkal.ac.in/Downloads/UG_SLM/Commerce/SEC_2.pdf

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx	2.2	1.2	1	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**

PROFESSIONAL ELECTIVE COURSES: VERTICAL 6

24BEMEXXXX **INDUSTRIAL SAFETY** **3H – 3C**

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Nil

COURSE OBJECTIVES: THE GOAL OF THIS COURSE IS FOR THE STUDENTS TO::

- To acquaint the student with the need and awareness of the safety concepts.
- To create an awareness on safety techniques involved in industrial sector.
- To learn the safety monitoring practices.

COURSE OUTCOMES:

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

CO1: Explain the significance of safety in industry	K2
CO2: Outline the safety techniques involved in an industrial sector.	K2
CO3: Identify the causes for an accident and prepare a report	K3
CO4: Identify the safety strategies and monitoring in industrial sector.	K3
CO5: Adopt safety standards in industry via suitable training.	K2

UNIT I CONCEPTS OF SAFETY ENGINEERING 9

Evolution of modern safety concept- Safety policy - Safety Organization - line and staff functions for safety- Safety Committee- budgeting for safety.

UNIT II TECHNIQUES OF SAFETY ENGINEERING 9

Incident Recall Technique (IRT), disaster control, Job Safety Analysis (JSA), safety survey, safety inspection, safety sampling, Safety Audit.

UNIT III ACCIDENT INVESTIGATION AND REPORTING 9

Concept of an accident, reportable and non-reportable accidents, unsafe act and condition – principles of accident prevention, Supervisory role- Role of safety committee – Accident causation models - Cost of accident. Overall accident investigation process - Response to accidents, India reporting requirement, Planning document, Planning matrix, Investigators Kit, functions of investigator, four types of evidences, Records of accidents, accident reports

UNIT IV SAFETY PERFORMANCE MONITORING 9

Reactive and proactive monitoring techniques - Permanent total disabilities, permanent partial disabilities, temporary total disabilities -Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety “t” score, safety activity rate – problems.

UNIT V SAFETY EDUCATION AND TRAINING 9

Importance of training-identification of training needs-training methods – programme, seminars, conferences, competitions – method of promoting safe practice – motivation – communication – role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training. Modern safety equipment and technics – Case study.

TOTAL: 45 PERIODS

TEXT BOOKS:

1.Accident Prevention Manual for Industrial Operations,3rd edition, N.S.C.Chicago, 2020 (digital).
2.Heinrich H.W. "Industrial Accident Prevention", 2ndedition, Tata McGraw-Hill, NewYork, 2017.

REFERENCE BOOKS:

1.Krishnan N.V, Safety Management in Industry,1st edition, Jaico Publishing House, Bombay, 2017.
2.John R Ridley, Safety at Work,3rd edition, Elsevier, 2019.

WEBSITES:

1. https://onlinecourses.nptel.ac.in/noc19_me40/preview
2. https://www.studocu.com/in/document/

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Cxxx.1	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.2	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.3	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.4	3	2	1	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx	2.4	1.4	1	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**

PROFESSIONAL ELECTIVE COURSES: VERTICAL 6

24BEMEXXXX	QUALITY CONTROL AND RELIABILITY ENGINEERING	3H – 3C

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

End Semester Exam: 3 Hours

PRE-REQUISITES: Nil

COURSE OBJECTIVES:

The goal of this course is for the students**:**

- To impart knowledge on the process control tools
- To familiarize with the different sampling plans
- To learn the importance of reliability and life testing.

COURSE OUTCOMES:

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

CO1: Explain the concepts of statistical quality control K2
CO2: Construct control charts for improving the process quality. K3
CO3: Solve problems using sampling techniques K3
CO4: Summarize the significance and types of life testing K2
CO5: Explain reliability and its relevance to quality K2

UNIT I INTRODUCTION AND PROCESS CONTROL FOR VARIABLES 9

Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality cost–Variation in process– factors – process capability – process capability studies and simple problems – Theory of control chart– uses of control chart – Control chart for variables – X chart, R chart and □ chart.

UNIT II PROCESS CONTROL FOR ATTRIBUTES 9

Control chart for attributes –control chart for proportion or fraction defectives – P chart and NP chart – control chart for defects – C and U charts, State of control and process out of control identification in charts.

UNIT III ACCEPTANCE SAMPLING 9

Lot by lot sampling – Types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts– standard sampling plans for AQL and LTPD– uses of standard sampling plans.

UNIT IV LIFE TESTING – RELIABILITY 9

Life testing – objective: – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability – simple problems. Acceptance sampling based on reliability test – O.C Curves.

UNIT V QUALITY AND RELIABLITY 9

Reliability improvements – techniques– use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product

analysis – Product development – Product life cycles – Maintenance.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Montgomery D. C. – 'Introduction to Statistical Quality Control' – John Wiley – 2010
2. Ebeling C. – 'An Introduction to Reliability and Maintainability Engineering' – Tata McGraw Hill Publishing Company Ltd. – 2004

REFERENCE BOOKS:

1. Eugene Grant and Richard Leavenworth, Statistical Quality Control, 7th edition, Tata McGraw–Hill, NewDelhi, 2017
2. Srinath L.S, Reliability Engineering, 4th edition, Affiliated East west press New Delhi, 2005.

WEBSITES:

1. https://nptel.ac.in/courses/110105039/
2. https://www.qualitygurus.com

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
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Cxxx.2	3	2	1	-	1	-	-	-	-	-	-	1	-	-
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Cxxx.4	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx.5	2	1	-	-	1	-	-	-	-	-	-	1	-	-
Cxxx	2.4	1.4	1	-	**1**	-	-	-	-	-	-	**1**	-	-