# ACADEMIC REGULATIONS

## COURSE STRUCTURE AND DETAILED SYLLABUS

### (CHOICE BASED CREDIT SYSTEM (CBCS))

# MASTER OF TECHNOLOGY
# IN
# CAD/CAM

**For**

**M.Tech. - Regular Two Year Post Graduate Degree Programme**

*(Applicable for the batches admitted from 2017 - 2018)*



## CMR INSTITUTE OF TECHNOLOGY

*(UGC - Autonomous)*

Approved by AICTE, Permanently Affiliated to JNTUH & Accredited by NBA

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# FOREWORD

CMR Institute of Technology, established in the year 2005 has been bestowed with autonomous status by the UGC from the academic year 2017-18 for its remarkable academic accomplishments accompanied by its unflinching spirit and dedication to impart quality technical education to the deserving aspirants. The institution has commenced functioning independently within the set norms prescribed by UGC and AICTE. The performance of the institution manifests the confidence that the prestigious monitoring body, the UGC has on it, in terms of upholding its spirit and sustenance of the expected standards of functioning on its own consequently facilitating the award of degrees for its students. Thus, an autonomous institution is provided with the necessary freedom to have its own **curriculum, examination system and monitoring mechanism**, independent of the affiliating University but under its observance.

CMR Institute of Technology takes pride for having won the confidence of such distinguished academic bodies meant for monitoring the quality in technology education. Besides, the institution is delighted to sustain the same spirit of discharging the responsibilities that it has been conveying since a decade to attain the current academic excellence, if not improving upon the standards and ethics. Consequently, statutory bodies such as the Academic Council and the Boards of Studies have been constituted under the supervision of the Governing Body of the college and with the recommendations of the JNTU Hyderabad, to frame the regulations, course structure and syllabi for autonomous status.

The autonomous regulations, course structure and syllabi have been framed in accordance with the vision and mission of the institution along with certain valuable suggestions from professionals of various ancillary fields such as the academics, the industry and the research, all with a noble vision to impart quality technical education and contribute in catering full-fledged engineering graduates to the society.

All the faculty members, the parents and the students are requested to study all the rules and regulations carefully and approach the Principal to seek any clarifications, if needed, without presumptions, to avoid unwanted subsequent inconveniences and embarrassments. The cooperation of all the stake holders is sought for the successful implementation of the autonomous system in the larger interests of the institution and for brightening the career prospects of engineering graduates.

**PRINCIPAL**

# CMR INSTITUTE OF TECHNOLOGY

**Vision:** To create world class technocrats for societal needs.

**Mission:** Impart global quality technical education for a better future by providing appropriate learning environment through continuous improvement and customization.

**Quality Policy:** Strive for global excellence in academics & research to the satisfaction of students and stakeholders.

## Department of ME

**Vision:**

- To be a centre of excellence committed to provide quality education and research for nurturing technically competent and socially responsible mechanical engineering professionals

**Mission:**

- Provide fundamentals and state of art technical knowledge in frontier areas of Mechanical Engineering.
- Emphasize on collaborative research and consultancy by initiating MOUs with industries and R&D organizations.
- Enrich self learning, professional ethics, entrepreneurship and leadership through effective interaction with stakeholders to handle real world challenges.

# M.Tech. - Regular Two Year Post Graduate Degree Programme
## (For batches admitted from the academic year 2017 - 18)

## PREAMBLE

For pursuing M.Tech. - Regular Two Year Post Graduate Degree Programme offered by **CMR Institute of Technology (CMRIT)** under Autonomous status will herein be referred to as CMRIT (Autonomous).

All the specified rules are herein approved by the Academic Council. These rules will be in force and are applicable to students admitted from the academic year 2017-18 onwards. Any reference to "**Institute**" or "**College**" in these rules and regulations stand for CMRIT (Autonomous).

All the rules and regulations specified shall hereafter be read as a whole for the purpose of interpretation, as and when a doubt arises, the interpretation of the Chairman, Academic Council is final. As per the requirements of statutory bodies, the Principal, CMRIT (Autonomous) shall be The Chairman, Academic Council.

## 1. POST GRADUATE PROGRAMS OFFERED

**CMR Institute of Technology,** an autonomous college affiliated to JNTUH, offers M.Tech. - Regular 2 years (4 semesters) Post Graduate Degree Programme, under Choice Based Credit System (CBCS) with effect from the academic year 2017 - 18 onwards. The following specializations are offered at present for the M. Tech. programme of study.

| Sl. No. | Programme | Offering Department |
|---|---|---|
| 1 | Structural Engineering | Civil Engineering |
| 2 | CAD/CAM | Mechanical Engineering |
| 3 | VLSI System Design | Electronics & Communication Engineering |
| 4 | Computer Science and Engineering | Computer Science and Engineering |

## 2. ADMISSION CRITERIA AND MEDIUM OF INSTRUCTION

### 2.1. Admission into first year of M.Tech. - Regular Two Year Post Graduate Degree Programme

**2.1.1 Eligibility:** A candidate seeking admission into the first year of M.Tech. shall be made subject to eligibility and qualification as prescribed by the university from time to time. Admissions shall be made on the basis of merit/rank obtained by the candidate qualified at TSPGECET/GATE or any entrance test conducted by the university or on the basis of any other order of merit as approved by the university, subject to reservations as laid down from time to time by government of Telangana.

**2.1.2 Admission Procedure:** Admissions are made into the first year M.Tech. as per the stipulations of the TSPGECET/GATE.

(a) Category A: 70% seats are filled through TSPGECET/GATE counselling.
(b) Category B: 30% seats are filled by the management.

**2.2. College Transfers:** There shall be no college transfers after the completion of admission process.

**2.3. Medium of Instruction:** The medium of instruction and examinations for the entire M.Tech. - Programme will be in **English** only.

## 3. M.Tech. PROGRAMME STRUCTURE

### 3.1 Admitted under M.Tech. - Regular Two Year Post Graduate Degree Programme:

**3.1.1** A student after securing admission shall pursue the post graduate programme in M.Tech. Programme for a minimum period of two academic years (4 semesters), and a maximum period of four academic years (8 semesters) starting from the date of commencement of first year first semester. However, he is permitted to write the examinations for two more years after four academic years of course work, failing which he shall forfeit his seat in M.Tech. Programme.

**3.1.2** Each semester of I year are structured to provide 28 credits and each semester of II year are structured to provide 16 credits totaling to 88 credits for the entire M.Tech. Programme.

**3.1.3** Each student shall secure 88 credits (with CGPA ≥ 5) required for the completion of the post graduate programme and award of the M.Tech. degree.

**3.2** **UGC/AICTE** specified definitions/ descriptions are adopted appropriately for various terms and abbreviations used in these academic regulations/ norms, which are listed below.

#### 3.2.1 Semester Scheme:

M.Tech. (Regular) Programme is of 2 academic years (4 semesters) with the academic year being divided into two semesters of 22 weeks (≥ 90 instructional days) each, each semester having - 'Continuous Internal Evaluation (CIE)' and 'Semester End Examination (SEE)', Choice Based Credit System (CBCS) and Credit Based Semester System (CBSS) as indicated by UGC and curriculum/course structure as suggested by AICTE / JNTUH.

#### 3.2.2 Credit Courses:

**a)** All subjects/courses are to be registered by a student in a semester to earn credits. Credits shall be assigned to each subject/course in a L : P : C (Lecture Periods: Practical Periods : Credits) structure, based on the following general pattern.

- One Credit - for One hour/Week/Semester for Theory/Lecture (L) Courses; and
- One Credit - for Two hours/Week/Semester for Laboratory/Practical (P) Courses

**b)** **Contact Hours:** Weekly contact hours - equal to 32 hours per week (i.e. 1 hour = 60 Minutes); for this an average course load of 28 credits per semester in first year and 16 credits per semester in second year.

## 4. COURSE REGISTRATION

**4.1** A **'Faculty Advisor or Counsellor'** shall be assigned to each students, who advises the student about the M.Tech. Programme, its course structure and curriculum, choice/option for subjects/courses, based on his/her competence, progress, and interest.

**4.2** Academic section of the college invites **'registration forms'** from students before the beginning of the semester through online submission, ensuring **'date and time stamping'**. The online registration requests for any '**current semester**' shall be completed **before** the commencement of Semester End Examinations (SEE) of the '**preceding semester**'.

**4.3** A student can apply for **online** registration, **only after** obtaining the written approval from his faculty advisor or counselor, which should be submitted to the College Academic Section through the Head of the Department. A copy of it shall be retained with the Head of the Department, the faculty advisor and the student.

**4.4** A student may be permitted to register for his/her subjects/course of **choice** with a total of 28 credits per semester of first year (Minimum of 24 credits and Maximum of 32 credits, permitted deviation being± 15%), based on his **progress** and SGPA/CGPA, and completion of the '**pre-requisites'** as indicated for various subjects/courses, in the department course structure and syllabus contents. However, a minimum of 24 credits per semester must be registered to ensure the studentship in any semester.

**4.5** Choice for 'additional subjects / courses' to reach the maximum permissible limit of 32 credits (above the typical 28 credit norm) must be clearly indicated, which needs the specific approval and signature of the faculty advisor/counsellor.

**4.6** If the student submits ambiguous choices or multiple options or erroneous (incorrect) entries during **online** registration for the subject(s)/course(s) under a given/specified course group/ category as listed in the course structure, only the first mentioned subject/course in that category will be taken into consideration.

**4.7** Subject/course options exercised through **online** registration are final and **cannot** be changed or inter-changed; further, alternate choices will not be considered. However, if the subject/course that has already been listed for registration by the Head of the Department in a semester could not be offered due to any unforeseen or unexpected reasons, then the student shall be allowed to have alternate choice - either for a new subject (subject to offering of such a subject), or for another existing subject (subject to availability of seats). Such alternate arrangements will be made by the Head of the Department, with due notification and time-framed schedule, within the **first week** from the commencement of class-work for that semester.

**4.8** Dropping of subjects/courses may be permitted, only after obtaining prior approval from the faculty advisor / counselor (subject to retaining a minimum of 24 credits), **'within 15 Days of time'** from the commencement of that semester.

**4.9** **Open Electives**: Students have to choose open elective-1 in I year I semester and open elective-2 in I year II semester from the open electives list as per course structure.

**4.10** **Core Electives**: Students have to choose two core electives (Core Elective-I and Core Elective-II) in I year I semester and another two core electives (Core Elective-III and Core Elective-IV) in I year II semester from the core electives list as per course structure.

## 5. SUBJECTS / COURSES TO BE OFFERED

**5.1** A Subject/Course may be offered to the Students, **if only** a minimum of 1/3 of students register to the course.

i) More than **one faculty member** may be allotted by the department for offer the **same subject** (lab/practical's may be included with the corresponding theory subject in the same semester) in any semester. However, selection choice for students will be based on '**first come first serve** basis and CGPA criterion' (i.e. the first focus shall be on early **online entry** from the student for registration in that semester, and the second focus, if needed, will be on CGPA of the student).

ii) If more entries for registration of a subject come into picture, then the concerned Head of the Department shall take necessary decision, whether or not to offer such a subject/ course for **two (or multiple) sections**.

## 6. ATTENDANCE REQUIREMENTS

**6.1** A Student shall be eligible to appear for the Semester End Examination (SEE) of any Subject / Course, if he acquires a minimum of 75% of attendance in that Subject / Course for that Semester.

**6.2** A Student's Seminar Report and Seminar Presentation shall be eligible for evaluation, only if he ensures a minimum of 75% of his attendance in Seminar Presentation Classes during that Semester.

**6.3** Condoning of shortage of attendance up to 10% (65% and above, and below 75%) in each Subject / Course of a Semester may be granted by the College Academic Council on genuine and valid grounds, based on the Student's representation with supporting evidence.

**6.4** A stipulated fee per Subject / Course shall be payable towards condoning of shortage of attendance.

**6.5** Shortage of Attendance below 65% in any Subject / Course shall in **NO** case be condoned.

**6.6** A Student, whose shortage of attendance is not condoned in any Subject(s) / Course (s) or seminar in any Semester, is considered as 'Detained in that Subject(s)/ Course(s)' or seminar, and is not eligible to take Semester End Examination(s) of such Subject(s) (and in case of Seminars, his Seminar Report or Presentation are not eligible for evaluation) in that Semester; and he has to seek Re-registration for those Subject(s) / Course (s) in subsequent Semesters, and attend the same as and when offered.

**6.7** A candidate shall put in a minimum required attendance at least three (3) theory subjects in each semester for promoting to next semester. In order to qualify for the award of the MTech Degree, the candidate shall complete all the academic requirements of the subjects, as per the course structure.

**6.8** A student shall not be promoted to the next semester unless he satisfies the attendance requirement of the present semester, as applicable. They may seek readmission into that semester when offered next.

**6.9** If any candidate fulfills the attendance requirement in the present semester, he shall not be eligible for **readmission into the same class.**

## 7. ACADEMIC REQUIREMENTS

The following academic requirements have to be satisfied, in addition to the attendance requirements mentioned in item no. 6.

**7.1** A Student shall be deemed to have satisfied the Academic Requirements and earned the Credits allotted to each Subject/ Course, if he secures not less than 40% Marks (28 out of 70 Marks) in the End Semester Examination, and a minimum of 50% of Marks in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together; in terms of Letter Grades, this implies securing B Grade or above in that Subject.

**7.2** A Student shall be deemed to have satisfied the Academic Requirements and earned the Credits allotted to - Seminar, and Comprehensive Viva-voce, if he secures not less than 50% of the total Marks to be awarded for each. The Student would be treated as failed, if he - (i) does not attend the Comprehensive Viva-voce as per the schedule given, or (ii) does not present the Seminar as required, or (iii) secures less than 50% of Marks ( < 50 Marks) in Seminar/ Comprehensive Viva-voce evaluations. He may reappear for comprehensive viva where it is scheduled again; for seminar, he has to reappear in the next subsequent Semesters, as and when scheduled.

**7.3** A Student shall register for all subjects covering 88 Credits as specified and listed in the Course Structure for the chosen M.Tech. Specialization, put up all the attendance and academic requirements for securing 88 Credits obtaining a minimum of B Grade or above in each Subject, and 'earn all 88 Credits securing SGPA $\geq$ 5.0 (in each Semester) and final CGPA (ie, CGPA at the end of M.Tech. Programme) $\geq$ 5.0, to successfully complete the M.Tech. Programme.

**7.4** Marks and Letter Grades obtained in all those Subjects covering the above specified 88 credits alone shall be considered for the calculation of final CGPA, which shall be indicated in the Grade Card of II Year II Semester.

**7.5** If a student registers for some more 'extra Subjects' (in the parent Department or other Departments/Branches of Engg.) other than those listed Subjects totaling to 88 Credits as specified in the Course Structure, the performances in those 'extra Subjects' (although evaluated and graded using the same procedure as that of the required 88 Credits) will not be taken into account while calculating the SGPA and CGPA. For such 'extra Subjects' registered, % marks and Letter Grade alone will be indicated in the Grade Card, as a performance measure, subject to completion of the Attendance and Academic Requirements as stated in Items 6 and 7.1 – 7.4 above.

**7.6** Students who fail to earn 88 Credits as per the specified Course Structure, and as indicated above, within 4 Academic Years from the date of Commencement of their I Year, shall forfeit their seats in M.Tech. Programme and their admissions shall stand cancelled.

**7.7** When a student is detained due to shortage of attendance in any subject(s)/seminar in any semester, no Grade Allotment will be done for such Subject(s)/Seminar, and SGPA/ CGPA calculations of that Semester will not include the performance evaluations of such subject(s)/seminar in which he got detained. However, he becomes eligible for re-registration of such subject(s)/seminar (in which he got detained) in the subsequent Semester(s), as and when next offered, with the Academic Regulations of the Batch into which he gets readmitted, by paying the stipulated fees per subject. In all these re-registration cases, the student shall have to secure a fresh set of Internal Marks (CIE) and End Semester Examination Marks (SEE) for performance evaluation in such subject(s), and subsequent SGPA/ CGPA calculations.

**7.8** A student eligible to appear in the Semester End Examination (SEE) in any subject, but absent at it or failed (failing to secure B Grade or above), may reappear for that subject at the supplementary examination (SEE) as and when conducted. In such cases, his Internal Marks (CIE) assessed earlier for that Subject/ Course will be carried over, and added to the marks to be obtained in the supplementary examination (SEE), for evaluating his performance in that Subject.

## 8. EVALUATION - DISTRIBUTION AND WEIGHTAGE OF MARKS

**8.1** The performance of a student in each semester shall be evaluated subject-wise / course-wise (irrespective of credits assigned) with a maximum of 100 marks for theory. For all theory subjects/practicals, the distribution shall be 30 marks for CIE, and 70 marks for the SEE, and a letter grade corresponding to the percentage of marks obtained shall be given.

### 8.2 Evaluation of Theory Subjects / Courses

**A) Continuous Internal Evaluation:** For each theory subject there shall be two mid-term examinations of 30 marks. Each mid-term examination consists of subjective paper for 25 marks and assignment for 5 marks. The better performance out of these two mid-term examinations shall be taken as the final marks secured by the student. The duration of each mid term examination is for 120 minutes. The first mid-term examination shall be conducted for the first 50% of the syllabus, and the second mid-term examination shall be conducted for the remaining 50% of the syllabus as per the academic calendar.

i) The subjective paper shall contain two parts i.e. Part A and Part B. Part A is compulsory question carries 10 marks for which there may be a 5 sub questions carries two mark each and Part B carries 15 marks for which there will be 3 essay questions with internal choice.

ii) The student should submit first assignment before the commencement of the first mid term examinations, and second assignment before the commencement of the second mid-term examinations.

**B) Semester End Examinations:** The duration of SEE is 3 hours. The details of the question paper pattern are as follows:

- The end semester examinations will be conducted for 70 marks consisting of two parts viz. i) **Part- A** for 20 marks, ii) **Part - B** for 50 marks.
- Part-A is compulsory question which consists of ten sub-questions (two from each unit) carries 2 marks each.
- Part-B consists of five questions (numbered from 2 to 6) carries 10 marks each. One question from each unit with internal choice (i.e., a or b).

**8.3 Evaluation of Practical Subjects/Courses:** In any semester, a student has to complete all exercises in each practical/laboratory course and get the record certified by the concerned Head of the Department to be eligible for Semester End Examination. For practical/laboratory Subjects, there shall be a Continuous Internal Evaluation (CIE) during the semester for 30 internal marks and 70 marks for Semester End Examination (SEE).

**A) Continuous Internal Evaluation (CIE):** Out of the 30 marks, 15 marks are allocated for day-to-day work evaluation and for remaining15 marks - two mid-term examinations of each 15 marks will be conducted by the concerned laboratory teacher for a duration of two hours and the better performance of the two mid-term examinations is taken into account.

**B) Semester End Examination (SEE):** The SEE for practical Subject / Course shall be conducted at the end of the semester by one Internal and one External Examiners appointed by the Head of the Institution as per the recommendation of the concerned Head of the Department.

**8.4 Evaluation of Seminar:** The student has to enroll and get approval for seminar on a specialized topic from the concerned Advisor / Counselor in the beginning of respective semester. There shall be two seminar presentations during I year I semester and II semester. For seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Departmental Academic Committee consisting of Head of the Department, Supervisor and two other senior faculty members of the department. For each Seminar there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful. If he fails to fulfill minimum marks, he has to **reappear** during the supplementary examinations.

**8.5 Evaluation of Comprehensive Viva:** There shall be a comprehensive viva-voce in II year I semester. The comprehensive viva-voce is intended to assess the students' understanding of various subjects he has studied during the M.Tech. course of study. The Head of the Department shall be associated with the conduct of the comprehensive viva-voce through a Committee. The Committee shall consist of Head of the Department, one senior faculty member and an external examiner. The external examiner shall be appointed by the Head of the Institution. For this, the Head of the department shall submit a panel of 3 examiners through Controller of Examinations. There are no internal marks for the comprehensive viva-voce and evaluated for maximum of 100 marks. A candidate has to secure a minimum of 50% of total marks to be declared successful. If he fails to fulfill minimum marks, he has to **reappear** during the supplementary examinations.

### 8.6 Evaluation of Project Work:

a) Every Student shall be required to execute his M.Tech. Project, under the guidance of the Supervisor assigned to him by the Head of the Department. The Project shall start immediately after the completion of the I Year II Semester, and shall continue through II Year I and II Semesters. The student shall carry out the literature survey, select an appropriate topic and submit a Project Proposal within 6 weeks (immediately after his I Year II Semester End Examinations), for approval by the Project Review Committee (PRC). The PRC shall be constituted by the Head of the Department, and shall consist of the Head of the Department, Project Supervisor, and two senior faculty members of the department. The student shall present his project work proposal to the PRC (PRC-I Presentation), on whose approval he can '**REGISTER** for the Project'. Every Student must compulsorily register for his M.Tech. Project Work, within the 6 weeks of time-frame as specified above. After registration, the student shall carry out his work, and continually submit 'a fortnightly progress report' to his Supervisor throughout the Project period. The PRC will monitor the progress of the project Work and review, through PRC-II and PRC-III Presentations – one at the end of the II Year I Semester, and one before the submission of M.Tech. project work report/ dissertation.

b) After PRC-III presentation, the PRC shall evaluate the entire performance of the Student and declare the Project Report as **'Satisfactory' or 'Unsatisfactory'**. Every Project Work Report/ Dissertation (that has been declared 'satisfactory') shall undergo **'Plagiarism Check'** as per the University/ College norms to ensure content plagiarism below a specified level of **30%**, and to become acceptable for submission. In case of unacceptable plagiarism levels, the student shall resubmit the project work report, after carrying out the necessary modifications/ additions to his project work/ report as per his Supervisor's advice, within the specified time, as suggested by the PRC.

c) If any student could not be present for PRC-II at the scheduled time (after approval and registration of his Project Work at PRC-I), his submission and presentation at the PRC-III time (or at any other PRC specified dates) may be treated as PRC-II performance evaluation, and delayed PRC-III dates for him may be considered as per PRC recommendations. Any Student is allowed to submit his MTech Project Dissertation **'only after completion of 40 weeks from the date of approval/registration'** of his Project, and after obtaining all approvals from the PRC.

d) After approval of project registration through PRC-I, a project work review-I will be conducted at the end of II year I semester for 100 marks through CIE only. Out of 100 marks the concernerd supervisor shall evaluate for 50 marks and remaining 50 marks by PRC-II. A candidate has to present and submit the project review-I report to the PRC-II. A candidate has to secure a minimum of 50% of total marks allotted. If he fails to fulfill minimum marks, he has to reappear during the supplementary examination.

e) A project work review-II will be conducted at the end of II year II semester for 100 marks through CIE only. Out of 100 marks the concernerd supervisor shall evaluate for 50 marks and remaining 50 marks by PRC-III. A candidate has to present and submit the project review-II report to the PRC-III. A candidate has to secure a minimum of 50% of total marks allotted. If he fails to fulfill minimum marks, he has to reappear during the supplementary examination.

f) A total of 100 Marks are allotted for the M.Tech. Project Evaluation (Viva-Voce) SEE and there shall be no internal evaluation (CIE). The student shall be allowed to submit his Project Dissertation, only on the successful completion of all the prescribed M.Tech. Subjects (Theory and Labs.), Seminar, Comprehensive Viva-voce (securing B Grade or above), and after obtaining all approvals from PRC successfully. In such cases the M.Tech. dissertation will be sent to an External Examiner nominated by the Principal of the college, on whose 'approval', the student can appear for the M.Tech. Project Viva-voce Examination, which shall be conducted by **exam panel**, consisting of the project supervisor, Head of the Department and the External Examiner who adjudicated the Project Work and Dissertation. The **exam panel** shall jointly evaluate the performance for 100 Marks (SEE).

g) If the adjudication report of the External Examiner is **'not favourable'**, then the student shall revise and resubmit his Dissertation as per the time specified by the PRC. If the resubmitted report is again evaluated by the External Examiner as **'not favourable'**, then that Dissertation will be summarily rejected. Subsequent actions for such Dissertations may be considered, only on the specific recommendations of the PRC.

h) In cases, where the **exam panel** declared the Project Work Performance as **'unsatisfactory'**, the student is deemed to have failed in the Project Viva-voce Examination, and he has to **reappear** for the Viva-voce Examination as per the **exam panel** recommendations. If he fails in the second Viva-voce Examination also, he will not be considered eligible for the Award of the Degree, unless he is asked to revise and resubmit his Project Work by the **exam panel** in a specified time (within 4 years from the date of commencement of his I Year I Semester).

## 9. GRADING PROCEDURE

**9.1** Marks will be awarded to indicate the performance of each student in each theory subject, lab/practical's, comprehensive viva-voce and project work. Based on t h e percentage of marks obtained in CIE+SEE (Continuous Internal Evaluation plus Semester End Examination), both taken together, as specified in item 10, and a corresponding letter grade shall be given.

**9.2** As a measure of the student's performance, a 10-point Absolute Grading System using the following Letter Grades (UGC Guidelines) and corresponding percentage of marks shall be followed.

| % of Marks Secured (Class Intervals) | Letter Grade (UGC Guidelines) | Grade Points |
|---|---|---|
| 90% and above | O (Outstanding) | 10 |
| Below 90% but not less than 80% | $A^+$ (Excellent) | 9 |
| Below 80% but not less than 70% | A (Very Good) | 8 |
| Below 70% but not less than 60% | $B^+$ (Good) | 7 |
| Below 60% but not less than 50% | B (Average) | 6 |
| Below 50% ( < 50% ) | F (Fail) | 0 |
| **Absent** | **Ab** | **0** |

**9.3** A student obtaining F grade in any subject/course shall be considered '**failed**' and will be required to reappear as '**Supplementary Candidate'** in the Semester End Examination (SEE), as and when offered. In such cases, his internal marks (CIE Marks) in those subject(s) will remain same as those he obtained earlier.

**9.4** A Letter Grade does not imply any specific % of marks.

**9.5** In general, a student shall not be permitted to repeat any subject/course (s) only for the sake of '**Grade Improvement'** or '**SGPA/CGPA Improvement'**. However, he has to repeat all the subjects/courses pertaining to that semester, when he is detained.

**9.6** A student earns **Grade Point** (GP) in each Subject/Course, on the basis of the letter grade obtained by him in that subject/course (excluding Mandatory non-credit courses). Then the corresponding '**Credit Points'** (CP) are computed by multiplying the grade point with credits for that particular subject/course.

**Credit Points (CP) = Grade Point (GP) x Credits … For a Course**

**9.7** The Student passes the subject/course only when he gets GP 5 (B Grade or above).

**9.8** The Semester Grade Point Average (SGPA) is calculated by dividing the sum of credit points ( CP) secured from **all** subjects/courses **registered** in a semester, by the total number of credits registered during that semester. SGPA is rounded off to **two** decimal places.

SGPA is thus computed as

$$SGPA \quad \{ \sum_{i=1}^{N} C_i G_i \} / \{ \sum_{i=1}^{N} C_i \} \quad \ldots \textbf{ for each semester},$$

where 'i' is the subject indicator index (takes into account all Subjects in a semester), **'N'** is the no. of subjects '**rigistered**' for the semester (as specifically required and listed under the course structure of the parent department), $C_i$ is the no. of credits allotted to that $i^{th}$ subject, and $G_i$ represents the grade points (GP) corresponding to the letter grade awarded for that $i^{th}$ subject.

**9.9** The Cumulative Grade Point Average (CGPA) is a measure of the overall cumulative performance of a student over all semesters considered for registration. The CGPA is the ratio of the total credit Points secured by a student in **all** registered Courses in **all** semesters, and the total number of credits registered in **all** the semesters. CGPA is rounded off to **two** decimal places. CGPA is thus computed from the I year II semester onwards, at the end of each semester, as per the formula

$$CGPA \{ \sum_{j=1}^{M} C_j G_j \} / \{ \sum_{j=1}^{M} C_j \} \ldots \textbf{ for all S semesters registered}$$

(i.e., upto and inclusive of S semesters, S ≥ 2)

where **'M'** is the total number of subjects (as specifically required and listed under the course structure of the parent department) the Student has '**registered**' from the I year I semester onwards upto and inclusive of the semester S (obviously M > N ), 'j' is the subject indicator index (takes into account all Subjects from 1 to S semesters), is the no. of credits allotted to the $j^{th}$ subject, and represents the Grade Points (GP) corresponding to the letter grade awarded for that $j^{th}$ subject. After registration and completion of I year I semester however, the SGPA of that semester itself may be taken as the CGPA, as there are no cumulative effects.

| Illustration of calculation of SGPA | | | | | Illustration of calculation of CGPA | | | |
|---|---|---|---|---|---|---|---|---|
| Course /Subject | Credits | Letter Grade | Grade Points | Credit Points | Semester | Credits | SGPA | Credits x SGPA |
| Course 1 | 4 | O | 10 | 40 | Sem I | 28 | 7.00 | 196 |
| Course 2 | 4 | $A^+$ | 9 | 36 | Sem II | 28 | 6.00 | 168 |
| Course 3 | 4 | A | 8 | 32 | Sem III | 16 | 6.50 | 104 |
| Course 4 | 4 | $B^+$ | 7 | 28 | Sem IV | 16 | 6.00 | 96 |
| Course 5 | 4 | B | 6 | 24 | Total | 88 | | 564 |
| Course 6 | 4 | F | 0 | 0 | CGPA= | 6.41 | | |
| Total | 24 | | | 160 | | | | |
| SGPA = 160/24 = 6.67 | | | | | | | | |

**9.10** For merit ranking or comparison purposes or any other listing, **only** the '**rounded off**' values of the CGPAs will be used.

**9.11** For calculations listed in item 9.6 to 9.10, performance in failed subjects/courses (securing '**F**' grade) will also be taken into account, and the credits of such subjects/courses will also be included in the multiplications and summations.

## 10 PASSING STANDARDS:

**10.1** A student shall be declared **'successful'** or **'passed'** in a semester, if student secures a GP ≥ 6.00 ('B' grade or above) in every subject/course in that semester (i.e. when student gets an SGPA 5.00 at the end of that particular semester); and a student shall be declared **'successful'** or **'passed'** in the entire post graduate programme, only when gets a CGPA 5.00 for the award of the degree as required.

**10.2** After the completion of each semester, a **'Grade Card' or 'Grade Sheet'** (or **Transcript**) shall be issued to all the registered students of that semester, indicating the letter grades and credits earned. It will show the details of the courses registered (course code, title, number of credits, grade earned etc.), credits earned, SGPA, and CGPA.

## 10 DECLARATION OF RESULTS

**11.1** Computation of SGPA and CGPA are done using the procedure in item Nos. 9.6 to 9.9.

**11.2** For final percentage of marks equivalent to the computed final CGPA, the following formula may be used:

**Percentage of Marks = (final CGPA – 0.5) x 10**

## 12 AWARD OF DEGREE

**12.1** After a student has satisfied the requirement prescribed for the completion of the Program and is eligible for the award of M.Tech. Degree he shall be placed in one of the following four classes based on CGPA:

| Class Awarded | Grade to be Secured | Remarks |
|---|---|---|
| First Class with Distinction | ≥ 8.00 CGPA | From the aggregate marks secured from 88 credits for regular students |
| First Class | ≥ 6.50 to < 8.00 CGPA | |
| Second Class | ≥ 5.50 to < 6.50 CGPA | |
| Pass Class | ≥ 5.00 to < 5.50 CGPA | |

**12.2** First Class with Distinction will be awarded to those students who clear all the subjects in single attempt during his/her regular course of study by fulfilling the following conditions:

(i) Should have passed all the subjects/courses in '**first appearance**' within the first 2 academic years (or 4 sequential semesters) for M.Tech.

(ii) Should have secured a CGPA ≥8.00, at the end of each of the 4 sequential semesters.

(iii) Should not have been detained or prevented from writing the Semester End Examinations in any semester due to shortage of attendance or any other reason, shall be placed in '**First Class with Distinction**'.

**12.3** **Award of Medals:** Students fulfilling the conditions listed under item 12.2 alone will be eligible for award of **'College ranks'** and **'Medals'**.

**12.4** **Transcripts:** After successful completion of prerequisite credits for the award of degree a transcript containing performance of all academic years will be issued as a final record. Duplicate transcripts will also be issued if required after the payment of requisite fee and also as per norms in vogue.

## 13 WITH HOLDING OF RESULTS

If the student has not paid the fee to college at any stage, or has dues pending against his/her name due to any reason what so ever, or if any case of indiscipline is pending against him/her, the result of the student may be withheld, and he/she will not be allowed to go into the next higher semester. The award or issue of the degree may also be withheld in such cases.

## 14 SUPPLEMENTARY EXAMINATIONS

Supplementary examinations for odd semester subject(s) / course (s) shall be conducted along with even semester regular examinations and vice versa.

## 15. TRANSITORY REGULATIONS

a) **Re-Registration for Detained Students:** When any Student is detained in a Subject (s)/ Seminar due to shortage of attendance in any Semester, he may be permitted to re-register for the same Subject in the 'same category' (Core or Elective Group) or equivalent Subject if the same Subject is not available, as suggested by the Board of Studies of that Department, as when offered in the sub-sequent Semester(s), with the Academic Regulations of the Batch into which he seeks re-registration , with prior permission from the concerned authorities, subject to Item 3.0.

b) **Re-Admission for Discontinued Students:** Students, who have discontinued the M.Tech. Degree Programme due to any reasons what so ever, may be considered for 'Readmission' into the same Degree Programme (with same specialization) with the Academic Regulations of the Batch into which he gets readmitted, with prior permission from the concerned authorities, subject to Item 3.0.

c) A Student - who has discontinued for any reason, or who has been detained for want of attendance as specified, or who has failed after having undergone M.Tech. programme, may be considered eligible for readmission to the same programme with same set of Subjects/ Courses (or equivalent Subjects/ Courses as the case may be), and same Professional Electives (or from same set/category of Electives or equivalents as suggested), as and when they are offered (within the timeframe of 4 years from the Date of Commencement of his I Year I Semester).

## 16 STUDENT TRANSFERS: There shall be no transfers from other colleges/streams.

## 17 RULES OF DISCIPLINE

**17.1** Any attempt by any student to influence the teachers, Examiners, faculty and staff of controller of Examination for undue favours in the exams, and bribing them either for marks or attendance will be treated as malpractice cases and the student can be debarred from the college.

**17.2** When the student absents himself, he is treated as to have appeared and obtained zero marks in that subject(s) and grading is done accordingly.

**17.3** When the performance of the student in any subject(s) is cancelled as a punishment for indiscipline, he is awarded zero marks in that subject(s).

**17.4** When the student's answer book is confiscated for any kind of attempted or suspected malpractice the decision of the Examiner is final.

## 18. MALPRACTICE

### 18.1 Malpractice Prevention Committee

A malpractice prevention committee shall be constituted to examine and punish the students who does malpractice / behaves indiscipline in examinations. The committee shall consist of:

a) Controller of Examinations - Chairman
b) Addl. Controller of Examinations.- Convener
c) Subject Expert - Member
d) Head of the Department of which the student belongs to - Member
e) The Invigilator concerned - Member

The committee shall conduct the meeting after taking explanation of the student and punishment will be awarded by following the malpractice rules meticulously.

Any action on the part of candidate at the examination like trying to get undue advantage in the performance at examinations or trying to help another, or derive the same through unfair means is punishable according to the provisions contained hereunder. The involvement of the Staff who are in charge of conducting examinations, valuing examination papers and preparing / keeping records of documents relating to the examinations, in such acts (inclusive of providing incorrect or misleading information) that infringe upon the course of natural justice to one and all concerned at the examination shall be viewed seriously and will be recommended for appropriate punishment after thorough enquiry.

**18.2 Malpractice Rules:** Disciplinary action for improper conduct in examinations

| S. No. | Nature of Malpractices / Improper Conduct | Punishment |
|---|---|---|
| 1 (a) | Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination. | Expulsion from the examination hall and cancellation of the performance in that subject only. |
| 1(b) | Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter. | Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him. |
| 2 | Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing. | Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the Principal. |
| 3 | Impersonates any other candidate in connection with the examination. | The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practical's and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police |

| | | |
|---|---|---|
| | | and a case is registered against him. |
| 4 | Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination. | Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. |
| 5 | Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks. | Cancellation of the performance in that subject. |
| 6 | Refuses to obey the orders of the Addl. Controller of examinations / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the addl. Controller of examinations or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the addl. Controller of examinations, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination. | In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them. |
| 7 | Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall. | Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course |

| | | |
|---|---|---|
| | | by the candidate is subject to the academic regulations in connection with forfeiture of seat. |
| 8 | Possess any lethal weapon or firearm in the examination hall. | Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. |
| 9 | If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8. | Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them. |
| 10 | Comes in a drunken condition to the examination hall. | Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. |
| 11 | Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny. | Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations. |
| 12 | If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the principal for further action to award suitable punishment. | |

## 19. SCOPE

i) The academic regulations should be read as a whole, for the purpose of any interpretation.

ii) The above mentioned rules and regulations are applicable in general to M.Tech., unless and otherwise specific.

iii) In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Chairman of the Academic Council is final.

## 20. REVISION AND AMENDMENTS TO REGULATIONS

The Academic Council may revise or amend the academic regulations, course structure or syllabi at any time, and the changes or amendments made shall be applicable to all students with effect from the dates notified by the Academic Council Authorities.

# COURSE STRUCTURE

# CMR INSTITUTE OF TECHNOLOGY, HYDERABAD

## (UGC AUTONOMOUS)

## M.Tech. (CAD/CAM)

## COURSE STRUCTURE

**I Year – I Semester**

| Course Code | Course Title | Int. marks | Ext. marks | L | P | C |
|---|---|---|---|---|---|---|
| 17ME1101CC | Advanced CAD | 30 | 70 | 4 | -- | 4 |
| 17ME1102CC | Computer Aided Manufacturing | 30 | 70 | 4 | -- | 4 |
| 17ME1103CC | Advanced FEM | 30 | 70 | 4 | -- | 4 |
| 17ME1104CE | Mechanical Behaviour of Materials<br>Stress Analysis and Vibration<br>Rapid Prototyping Technologies | 30 | 70 | 4 | -- | 4 |
| 17ME1105CE | Automation in Manufacturing<br>Computer Aided Process Planning<br>Performance Modeling and Analysis of Manufacturing Systems | 30 | 70 | 4 | -- | 4 |
| 17ME1106OE | Numerical Methods for Partial Differential Equations<br>Production and Operations Management | 30 | 70 | 4 | -- | 4 |
| 17ME1107CC | Advanced CAD Laboratory | 30 | 70 | -- | 4 | 2 |
| 17ME1108CC | Seminar | 100 | -- | -- | 4 | 2 |
| **Total Credits** | | | | **24** | **8** | **28** |

**I Year – II Semester**

| Course Code | Course Title | Int. marks | Ext. marks | L | P | C |
|---|---|---|---|---|---|---|
| 17ME1201CC | Design for Manufacturing And Assembly | 30 | 70 | 4 | -- | 4 |
| 17ME1202CC | Flexible Manufacturing Systems | 30 | 70 | 4 | -- | 4 |
| 17ME1203CC | Industrial Robotics | 30 | 70 | 4 | -- | 4 |
| 17ME1104CE | Intelligent Manufacturing Systems<br>Special Manufacturing Process<br>Design Optimization | 30 | 70 | 4 | -- | 4 |
| 17ME1105CE | Advanced Mechatronics<br>Design and Manufacturing of MEMS and Micro Systems<br>Fuzzy Logic and Neural Networks | 30 | 70 | 4 | -- | 4 |
| 17ME1106OE | Engineering Research and Methodology<br>Quality Engineering in Manufacturing | 30 | 70 | 4 | -- | 4 |
| 17ME1207CC | Advanced Computer Aided Manufacturing Lab | 30 | 70 | -- | 4 | 2 |
| 17ME1208CC | Seminar | 100 | -- | -- | 4 | 2 |
| **Total Credits** | | | | **24** | **8** | **28** |

**II Year - I Semester**

| Course Code | Course Title | Int. Marks | Ext. marks | L | P | C |
|---|---|---|---|---|---|---|
| 17ME2101CC | Comprehensive Viva -Voce | -- | 100 | -- | -- | 4 |
| 17ME2102CC | Project work Review I | 100 | -- | -- | 24 | 12 |
| **Total Credits** | | | | -- | **24** | **16** |

**II Year - II Semester**

| Course Code | Course Title | Int. Marks | Ext. Marks | L | P | C |
|---|---|---|---|---|---|---|
| 17ME2201CC | Project work Review II | 100 | -- | -- | 8 | 4 |
| 17ME2202CC | Project Evaluation (Viva-Voce) | -- | 100 | -- | 16 | 12 |
| **Total Credits** | | | | -- | **24** | **16** |

**M.Tech. I Year I-Semester (CAD/CAM)**

| L | P | C |
|---|---|---|
| 4 | - | 4 |

## ADVANCED CAD

### COURSE OBJECTIVES

1. Learn and apply all of the steps of the computer aided design process in proposing and building models in design projects
2. The objective of the topics is to know the tools, Graphics standards, Graphics software: requirements of software graphics, Functional areas of CAD, Efficient use of CAD software and geometric modeling.
3. To expose the students Classification of wireframe entities, Curve representation methods, parametric representation of analytic curves: Hermit cubic curve, Bezier curve, B-Spleen curve wire, NURBS, Curve manipulations.
4. Uses have to know the classification of surface entities, Surface representation methods, Parametric representation of analytic surfaces: plane surface, ruled surface, surface of revolution, tabulated cylinder, Parametric representation of synthetic curves:
5. The objective of the Geometry and topology, Boundary representation, The Euler-Poincare formula, Euler operators, Constructive solid geometry: CSG primitives, Boolean operators, CSG expressions, Interior, Exterior, closure, Sweeping: linear and non-linear, Solid manipulations.
6. The design of translation, scaling, rotation, reflection, concatenation, homogeneous coordinates, Perspective projection, orthotropic projection, isometric Projection, hidden surface removal, shading, rendering.

### COURSE OUTCOMES

1. Students develop awareness in the application of CAD in the context of developing engineering products
2. Students understand the basic concepts of computer, computer Graphics and components of CAD Systems.
3. Students understand the creation of different wireframes and method of representation curves.
4. Students learn the surface entities, surface methods and parametric representation of synthetic curves.
5. Students understand the GT Based on boundary representation of different methods are displayed in computer aided planning.
6. Students understand the 2-D and 3-D transformations of ADVANCED CAD systems and Human being involvements in cad system.

**UNIT- I:**

**CAD Tools:** Definition of CAD Tools, Graphics standards, Graphics software: requirements of graphics software, Functional areas of CAD, Efficient use of CAD software.

**Basics of Geometric Modelling:** Requirement of geometric modelling, Geometric models, Geometric construction methods, Modelling facilities desired.

**UNIT- II:**

**Eometricmodelling:** Classification of wireframe entities, Curve representation methods, Parametric representation of analytic curves: line, circle, arc, conics, Parametric representation of synthetic Curves: Hermite cubic curve, Bezier curve, B-Spleen curve wire, NURBS, Curve manipulations.

**UNIT- III:**

**Surface Modeling** : Classification of surface entities, Surface representation methods, Parametric Representation of analytic surfaces: plane surface, ruled surface, surface of revolution, tabulated cylinder, parametric representation of synthetic curves: Hermite cubic surface, Bezier surface, B-Spleen surface, Blending surface, Surface manipulations.

**UNIT- IV:**

**Solid Modelling:** Geometry and topology, Boundary representation, The Euler-Poincare formula, Euler operators, Constructive solid geometry: CSG primitives, Boolean operators, CSG expressions, Interior, Exterior, closure, Sweeping: linear and non-linear, Solid manipulations.

**UNIT- V:**

**Transformations:** @-D and 3-D transformations: translation, scaling, rotation, reflection, concatenation, homogeneous coordinates, Perspective projection, orthotropic projection, isometric projection, Hidden surface removal, shading, rendering.

**Evaluation Criteria**: Evaluation criteria of CAD software, Data exchange formats: GKS, IGES, PHIGS, CGM, and STEP

Dimensioning and tolerances: Linear, angular, angular dimensions, maximum material condition (MMC), Least material condition (LMC), Regardless of feature size (RFS).

**TEXT BOOKS:**

1. CAD/CAM Concepts and Applications/ Alavala/ PHI.
2. Mastering CAD/CAM / Ibrhim Zeid / Mc Graw Hill International.

**REFERENCES:**

1. CAD/CAM Principles and Applications/ P.N.Rao/TMH/3rd Edition
2. CAD/CAM /Groover M.P./ Pearson education
3. CAD / CAM / CIM, Radhakrishnan and Subramanian/ New Age
4. Principles of Computer Aided Design and Manufacturing/ Farid Amirouche/ Pearson
5. Computer Numerical Control Concepts and programming/ Warren S Seames/ Thomson.

**M.Tech. I Year I-Semester (CAD/CAM)** **L P C**
**4 - 4**

## COMPUTER AIDED MANUFACTURING

### COURSE OBJECTIVES

1. To impart knowledge on programming. To introduce Expert Systems and Applications
2. To describe the concepts of APT programming, NC, post processor Systems and develop part programming.
3. To describe the concepts of tooling system, coolant feed, quick change tooling system, DNC Systems and Adaptive Control and develops the Tooling for CNC Machines
4. Users have to know Post Processors for CNC and DAPP based- Post Processor.
5. To learn based on Micro Controllers in CNC and Hardware components of PLC systems and applications PLC in CNC Systems
6. The objective of CAPP is to communicate with the CAM systems and describe the computer aided inspection and quality control in CAPP systems.

### COURSE OUTCOMES

1. Students will be able to understand structure of different expert systems employed in industries.
2. Students understand the basic concepts of computer, computer Graphics and components of CAM Systems.
3. Students understand the creation of new models with help of CNC Machines.
4. Students understand the Post Processors used in CNC systems and develop DAPP Based Post Processor.
5. Students learn the Micro Controllers in pins, interrupts, Controllers and applications of PLC systems
6. Students understand the inspection of parts using computer controlled CMM and by Non- Contact inspection methods.

### UNIT - I

**Computer-Aided Programming**: General information, APT programming, Examples Apt programming Problems (2D machining only). NC programming on CAD/CAM systems, the design and implementation of post processors .Introduction to CAD/CAM software, Automatic Tool ath Generation.

### UNIT - II

**Tooling for CNC Machines:** Interchangeable tooling system, preset and qualified tools, coolant fed tooling system, modular fixturing, quick change tooling system, automatic head changers. DNC Systems and Adaptive Control: Introduction, type of DNC systems, advantages arid disadvantages of DNC, adaptive control with optimization, Adaptive control with constrains, Adaptive control of machining processes like turning, grinding.

### UNIT - III

**Post Processors for CNC:**
Introduction to Post Processors: The necessity of a Post Processor, the general structure of a Post Processor, the functions of a Post Processor, DAPP — based- Post Processor: Communication channels and major variables in the DAPP — based Post Processor, the creation of a DAPP — Based Post Processor.

### UNIT - IV

**Micro Controllers:** Introduction, Hardware components, I/O pins, ports, external memory:, counters, timers and serial data I/O interrupts. Selection of Micro Controllers Embedded Controllers, Applications and Programming of Micro Controllers. Programming Logic Controllers (PLC' s): Introduction, Hardware components of PLC, System, basic structure, principle of operations, Programming mnemonics timers, Internal relays and counters, Applications of PLC's in CNC Machines.

**UNIT - V**

**Computer Aided Process Planning**: Hybrid CAAP System, Computer Aided Inspection and quality control, Coordinate Measuring Machine, Limitations of CMM, Computer Aided Testing, Optical Inspection Methods, Artificial Intelligence and expert system: Artificial Neural Networks, Artificial Intelligence in CAD, Experts systems and its structures.

**TEXT BOOKS:**

1. CAD/CAM Concepts and Applications/ Alavala/ PHI.
2. CAD/CAM Principles and Applications, P.N.Rao, TMH

**REFERENCES:**

1. Computer Control of Manufacturing Systems / Yoram Koren / Mc Graw Hill. 1983.
2. Computer Aided Design Manufacturing – K. Lalit Narayan, K. Mallikarjuna Rao and M.M.M. Sarcar, PHI, 2008.
3. CAD / CAM / CIM, Radhakrishnan and Subramanian, New Age
4. Principles of Computer Aided Design and Manufacturing, Farid Amirouche, Pearson
5. Computer Numerical Control Concepts and programming, Warren S Seames, Thomson.

**M.Tech. I Year I-Semester (CAD/CAM)** **L P C**
**4 - 4**

## ADVANCED FINITE ELEMENT METHODS

### COURSE OBJECTIVES

1. To impart knowledge in the area of finite element methods and its application in manufacturing.
2. The objective of the advanced topics in Finite Element methods so that this tool can be used for analysis, design, and optimization of engineering systems.
3. To apply finite element method for solving 1-D Structural Problems Analysis of Trusses Plane Trusses and Space Truss elements and problems and Analysis of BECAD/CAM.
4. To apply finite element method for solving 2-D Structural Problems Stiffness matrix and load vectors, boundary conditions and Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements.
5. To apply finite element method for solving 1-D Heat conduction, Slabs, fins, 2-D heat conduction problems, Introduction to Torsional problems.
6. To apply finite element method for non linear and structural dynamic problem.

### COURSE OUTCOMES

1. Students will be able to use the FEA in manufacturing applications.
2. To learn the Students the advanced topics in Finite Element methods using optimization of engineering systems.
3. Students understand the creation of new models with 1-D Structural Problems Analysis of Trusses Plane Trusses and Space Truss elements and problems
4. Students understand the 2-D Structural Problems Stiffness matrix and load vectors, boundary conditions and Finite element modeling.
5. Students learn the 1-D Heat conduction, Slabs, fins, 2-D heat conduction problems, Introduction to Torsional problems.
6. Students understand the Analyze linear, nonlinear and simple time-dependent problems in structural discipline using finite element methods.

**UNIT-I:**

Introduction to FEM, basic concepts, historical back ground, applications of FEM, general description, comparison of FEM with other methods, variational approach, Glerkin's Methods. Co-ordinates, basic element shapes, interpolation function, Virtual energy principle, Rayleigh – Ritz method, properties of stiffness matrix, treatment of boundary conditions, solution of system of equations, shape functions and characteristics, Basic equations of elasticity, strain- displacement relations.

**UNIT-II:**

**1-D Structural Problems**: Axial bar element – stiffness matrix, load vector, temperature effects, Quadratic shape functions and problems.
**Analysis of Trusses** : Plane Trusses and Space Truss elements and problems
**Analysis of BECAD/CAM** : Hermite shape functions – stiffness matrix – Load vector – Problems.

**UNIT-III:**

**2-D problems:** CST, LST, force terms, Stiffness matrix and load vectors, boundary conditions, Isoparametric elements – quadrilateral element, shape functions – Numerical Integration. Finite Element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular Elements.
**3-D Problems**: Tetrahedron element – Jacobian matrix – Stiffness matrix.

**UNIT-VI:**

**Scalar Field Problems**: 1-D Heat conduction-Slabs – fins - 2-D heat conduction problems – Introduction to Torsional problems.

**UNIT-V:**

Dynamic considerations, Dynamic equations – consistent mass matrix – Eigen Values, Eigen vector, natural frequencies – mode shapes – modal analysis.

**TEXT BOOKS:**

1. Finite Element Methods: Basic Concepts and applications, Alavala, PHI.
2. Finite Element Method – Zincowitz / Mc Graw Hill

**REFERENCES:**

1. The Finite Element Methods in Engineering / SS Rao / Pergamon.
2. Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu, Prentice Hall
3. Introduction to Finite element analysis- S.Md.Jalaludeen,Anuradha Publications, print-2012
4. A First Course in the Finite Element Method/Daryl L Logan/Cengage Learning/5th Edition
5. Finite Element Method – Krishna Murthy / TMH
6. Finite Element Analysis – Bathe / PHI

**M.Tech. I Year I-Semester (CAD/CAM)**

| L | P | C |
|---|---|---|
| 4 | - | 4 |

## MECHANICAL BEHAVIOUR OF MATERIALS
**(Core Elective – I)**

**Course objectives:**

1. Comprehension of the structure of material over the effects and defects inside the structure and their effects on the of mechanical properties
2. To explain the concept of stress strain for different metals
3. To explain elastic theory and behavior of different metals, ceramics and polymers
4. To explain the plastic deformation, dislocation, classification and its defects.
5. To explain the fracture mechanics in the design of metals, ceramics and polymers and its applications
6. Explain the concept of deformation under cyclic load in different metals and at high temperatures

**Course outcomes:**

1. Acquiring the basic level knowledge of Materials Science and Engineering Utilizing state of the art techniques in the area of Materials Science and Engineering
2. Student should able to understand the concept of stress strain for different metals.
3. An ability to analyze the behavior of elastic theory and behavior of different metals, ceramics and polymers
4. To understand the concept plastic deformation, dislocation, classification and its defects.
5. Student should able to understand the concept Design based on fracture mechanics
6. To analyze and high cycle fatigue, Life cycle prediction and dependent deformation high temperature deformation of ceramics and polymers.

**UNIT-I:**

**Introduction to Deformation Behaviour:** Concept of stresses and strains, engineering stresses and strains, Different types of loading and temperature encountered in applications, Tensile Test - stress-strain response for metal, ceramic and polymer, elastic region, yield point, plastic deformation, necking and fracture, Bonding and Material Behaviour, theoretical estimates of yield strength in metals and ceramics.

**UNIT-II:**

**Elasticity Theory:** The State of Stress and strain, stress and strain tensor, tensor transformation, principal stress and strain, elastic stress-strain relation, anisotropy, elastic behaviour of metals, ceramics and polymers.

**Yielding and Plastic Deformation:** Hydrostatic and Deviatoric stress, Octahedral stress, yield criteria and yield surface, texture and distortion of yield surface, Limitation of engineering strain at large deformation, true stress and true strain, effective stress, effective strain, flow rules, strain hardening, RambergOsgood equation, stress -strain relation in plasticity, plastic deformation of metals and polymers

**UNIT-III:**

**Microscopic view of plastic deformation:** crystals and defects, classification of defects, thermodynamics of defects, geometry of dislocations, slip and glide, dislocation generation - Frank Read and grain boundary sources, stress and strain field around dislocations, force on dislocation - self-stress, dislocation interactions, partial dislocations, twinning, dislocation movement and strain rate, deformation behavior of single crystal, critical resolved shear stress (CRSS), deformation of poly-crystals - Hall-Petch and other hardening mechanisms, grain size effect - source limited plasticity, Hall-Petch breakdown, dislocations in ceramics and glasses.

**UNIT-IV:**

**Fracture:** fracture in ceramics, polymers and metals, different types of fractures in metals, fracture mechanics - Linear fracture mechanics -KIC, elasto-plastic fracture mechanics - JIC, Measurement and ASTM standards, Design based on fracture mechanics, effect of environment, effect of microstructure on KIC and JIC, application of fracture mechanics in the design of metals, ceramics and polymers

**UNIT-V:**

**Deformation under cyclic load** - Fatigue: S-N curves, Low and high cycle fatigue, Life cycle prediction, Fatigue in metals, ceramics and polymers

**Deformation at High temperature:** Time dependent deformation - creep, different stages of creep, creep and stress rupture, creep mechanisms and creep mechanism maps, creep under multi-axial loading, micro structural aspects of creep and design of creep resistant alloys, high temperature deformation of ceramics and polymers.

**REFERENCES:**

1. G.E. Dieter, “Mechanical Metallurgy", McGraw-Hill, 1986.
2. R.W. Hertzberg, “Deformation and Fracture Mechanics of Engineering Materials", John Wiley and Sons, 1976.

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## STRESS ANALYSIS AND VIBRATION
## (Core Elective – I)

**Course objectives:**

1. Understand elastic theory and Plane stress concept. Understand application of Torsion concept on noncircular, prismatic, rectangular,
2. To explain Axisymmetric components. Identify the causes and effects of Vibration of Single and Multi degree freedom systems.
3. To teach about Investigate free
4. What is Forced vibrations of strings bars and beams.
5. To explain about principle of orthogonality-
6. Applications of matrix methods, continuous systems.

**Course outcomes:**

1. Students will be able to: Apply the concept of elastic theory on component under plane stresses.
2. To apply fundamentals to identify causes and effects of vibrations.
3. To know how toFind out intensity of vibrations in a given system.
4. How to Solve the free and forced vibrations of continuous system
5. To learn concept of Free and forced vibrations of strings bars and beCAD/CAM
6. To know the concept of stress analysis and vibration analysis

**UNIT-I:**

Two dimensional elasticity theory in Cartesian coordinates, plane stress problem in polar coordinates thick cylinders, Rotating discs - stress concentration.

**UNIT- II:**

Torsion of non circular prismatic sections, rectangular and axisymmetric, Circular plates, introduction to shell theory — contact stresses.

**UNIT- III:**

Single degree freedom, two degree freedom system without and with damping - Free and forced vibrations. Transient vibrations.

**UNIT- IV:**

Transient vibrations of single and two degree freedom systems, multi-degree of freedom systems - applications of matrix methods , continuous systems.

**UNIT -V**:

Free and forced vibrations of strings bars and beCAD/CAM. Principle of orthogonality - classical and energy methods.

**REFERENCES:**

1. Theory of Elasticity/Timoshenko S.P. and Goodier J.N./Koakusha Publishers
2. Advanced strength of materials / Den Hortog J.P./Torrent
3. Mechanical Vibrations/ Den Ilartog J.P./ Dover Publications
4. Theory of Vibrations with Applications/ Thomson W.T./ CBS Publishing
5. Mechanical Vibrations/ Rao S.S./ Addison Wesley Longman

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## RAPID PROTOTYPING TECHNOLGIES
**(Core Elective – I)**

**Course objectives:**

1. Participants will study topics fundamental to rapidprototyping and automated fabrication iIncluding the generation of suitable CAD models
2. To learn Currentrapid prototyping fabrication technologies, theirunderlying material science
3. Learn the use of secondaryprocessing, and the impact of these technologies on society.
4. The rapid prototyping process will beillustrated by the actual design and fabrication of a part.
5. To know Application – Material Relationship

**Course outcomes:**

1. The students who succeeded in this course;
2. Describe the current available rapid prototyping systems.
3. Their fundamental operating principles,and their characteristics
4. Describe complementary, secondary fabrication processes commonly used with the above rapid prototyping systems
5. Select the appropriate fabrication technology, or technologies, for a given prototyping task
6. Students will learn about Visualization of Biomolecules

**Unit – I**

Introduction: Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, Commonly used Terms, Classification of RP process, Rapid Prototyping Process Chain: Fundamental Automated Processes, Process Chain.

**Unit – II**

Liquid-based Rapid Prototyping Systems: Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopo l ymers, photo po l ymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies Solid-based Rapid Prototyping Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

**Unit-III**

Powder Based Rapid Prototyping Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs. RT, Need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, Investment Casting, Spin Casting, Die casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

**Unit – IV**

Rapid Prototyping Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Rapid Prototyping Software's: Features of various RP software's like Magic's, Mimics, Solid View, View Expert, 3 D View, Velocity 2 , Rhino, STL View 3 Data Expert and 3 D doctor.

**Unit –V**

RP Applications: Application – Material Relationship, Application in Design , Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules.

**TEXT BOOKS:**

1. Rapid prototyping: Principles and Applications - Chua C.K., Leong K.F. and LIM C.S, World Scientific publications , Third Edition, 2010.

**REFERANCE BOOKS:**

1. Rapid Manufacturing – D.T. Pham and S.S. Dimov, Springer , 2001
2. Whalers Report 2000 – Terry Wohlers, Wohlers Associates, 2000 Rapid Prototypin Manufacturing – Paul F.Jacobs, ASME Press, 1996.

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## AUTOMATION IN MANUFACTURING
## (Core Elective – II)

**Course objectives:**

1. Understand the basic principles of automation and tool transfer,
2. Students will learn how Implementation of automated flow line.
3. Understand design aspects and analysis of material handling system.
4. To Understand ways of improving line balance and solving line balancing problems.
5. Students will learn Quality in Design and manufacturing
6. Students will learn CMM. Manufacturing support systems. Quality function deployment

**Course outcomes:**

1. Students will be able to: Implement concepts of a productive system in automation.
2. Apply the concepts of automated flow lines and design technologies.
3. Apply it in material handling systems for balancing assembly lines.
4. Students will learn about analysis of material handling system.
5. To know the Quality in Design and manufacturing
6. Automated Assembly System & Quality Control and Support Systems

**UNIT – I**

**Over View of Manufacturing and Automation**: Production systems, Automation in production systems, Automation principles and strategies, Manufacturing operations, production facilities. Basic elements of an automated system, levels of automation; Hardware components for automation and process control, programmable logic controllers and personal computers.

**UNIT – II:**

**Material Handling and Identification Technologies**: Material handling, equipment, Analysis. Storage systems, performance and location strategies, Automated storage systems, AS/RS, types. Automatic identification methods, Barcode technology, RFID.

**UNIT – III:**

**Manufacturing Systems and Automated Production Lines:** Manufacturing systems: components of a manufacturing system, Single station manufacturing cells; Manual Assembly lines, line balancing Algorithms, Mixed model Assembly lines, Alternative Assembly systems. Automated production lines, Applications, Analysis of transfer lines.

**UNIT – IV:**

**Automated Assembly Systems:** Fundamentals, Analysis of Assembly systems. Cellular manufacturing, part families, cooling, production flow analysis. Group Technology and flexible Manufacturing systems, Quantitative Analysis.

**UNIT – V:**

**Quality Control and Support Systems:** Quality in Design and manufacturing, inspection principles and strategies, Automated inspection, contact Vs non contact, CMM. Manufacturing support systems. Quality function deployment, computer aided process planning, concurrent engineering, shop floor control, just in time and lean production.

**REFERENCES:**


1. Automation, production systems and computer integrated manufacturing/ Mikell.P Groover/PHI/3rd edition/2012.
2. Automation, Production Systems and CIM/ Mike J P. Grower/PHI
3. CAD/CAM/CIM/ P. **R**adha Krishnan **& S**. Subrahamanyarn and Raju/New Age International Publishers/2003.
4. System Approach to Computer Integrated Design and Manufacturing/ Singh/John Wiley /96.
5. Computer Aided Manufacturing/Tien-Chien Chang, Richard A. Wysk and Hsu-Pin Wang/ Pearson/ 2009.
6. Manufacturing and Automation Technology / R Thomas Wright and Michael Berkeihiser / Good Heart/Willcox Publishers

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## COMPUTER AIDED PROCESS PLANNING
## (Core Elective – II)

**Course objectives:**

1. To understand know the various steps involved in CAPP, classify the various methods of CAPP, and understand the feature recognition in CAPP.
2. To explain Process Planning in the Manufacturing cycle
3. To learn Part Design Representation .Design Drafting Geometric transformation
4. Explain Process Engineering and Process Planning Experience based planning forward and backward planning
5. What is Logical Design of process planning- Implementation considerations
6. To explain what integrated process planning systems-An Overview Expert process planning

**Course outcomes:**

1. Student should able to know the various methods of CAPP
2. To learn Process planning in the Manufacturing cycle CAPP, Group Technology.
3. Student should able to understand the concept of Design Drafting-Dimensioning-Conventional Tolerance
4. To understand necessity of Process engineering and Process Planning
5. An ability to learn what is Logical Design of process planning No. of production families
6. To know what is Data Structure, Operation, Report Generation and Expert process planning

**UNIT-I:**

**Introduction: The** Place of Process Planning in the Manufacturing cycle-Process planning and production Planning-Process planning and Concurrent Engineering, CAPP, Group Technology.

**UNIT-II:**

**Part Design Representation: Design** Drafting-Dimensioning-Conventional Tolerance- Geometric Tolerance-CAD-input/output devices-Topology - Geometric transformation-Perspective transformation-Data Structure-Geometric modeling for process planning--GT Coding-The OPITZ system-The MICLASS System.

**UNIT-III;**

**Process Engineering and Process Planning:** Experience based planning-Decision table and Decision trees-Process capability analysis-Process planning-Variant process planning-Generative approach-Forward and backward planning, Input format, AI.

**UNIT-IV**

**Computer Aided Process Planning Systems:** Logical Design of process planning- Implementation considerations-Manufacturing system components, Production Volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

**UNIT-V**

**An Intergarted Process Planning Systems:**Totally integrated process planning systems-An Overview-Modulus structure-Data Structure-Operation-Report Generation, Expert process planning

**REFERENCE BOOKS:**


1. Gideon Halevi and Roland D. Weill, "Principle of process planning- A Logical Approach", Chapman & Hall, 1995
2. Chang T. C. & Richard A.Wysk, "An Introduction to automated process planning systems", PrenticeHall1985
3. Chang,T.C., "An Expert Process Planning System", Prentice Hall,1985
4. Nanua Singh, "Systems Approach to Computer Intergrated Design and Manufacturing", John Wiley &Sons,1996
5. Rao P.N., "Computer Aided Manufacturing", Tata McGraw Hill Publishing Co., 2000.

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**PERFORMANCE MODELING AND ANALYSIS OF MANUFACTURING SYSTEMS (Core Elective – II)**

**Course objectives:**

1. To introduce concept of control of manufacturing systems.
2. To impart knowledge on queuing model
3. To impart networks to control manufacturing processes.
4. To understand Examples of QN models in manufacturing models
5. Explain the concept of Classical Petri Nets, Exponential timed Petri Nets
6. To learn about Manufacturing Systems Manufacturing Processes

**Course outcomes:**

1. Students will be able to demonstrate how Quality Control system is modeled in industry.
2. Students will be able to demonstrate a basic understanding of network models employed in manufacturing industry and Equations for CTMC evolution
3. To learn Queing model Examples of queues in manufacturing systems
4. Students will be able to queuing networks
5. Students will be able to demonstrate how modeling of KANBAN systems system is modeled in industry
6. To know about Manufacturing Systems Manufacturing Processes

**UNIT I:**

**Manufacturing Systems & Control:** Automated Manufacturing Systems – Modeling – Role of performance modeling – simulation models-Analytical models. Product cycle – Manufacturing automation – Economics of scale and scope – input/output model – plant configurations. Performance measures – Manufacturing lead time – Work in process – Machine utilization – Throughput – Capacity– Flexibility – Performability – Quality Control Systems – Control system architecture – Factory communications – Local area network interconnections – Manufacturing automation protocol – Database management system.

**UNIT II:**

**Manufacturing Processes:** Examples of stochastics processes – Poisson process - Discrete time Markov chain models – Definition and notation – Sojourn times in states – Examples of DTMCs in manufacturing – Chapman – Kolmogorov equation – Steady-state analysis. Continuous Time Markov Chain Models – Definitions and notation – Sojourn times in states – examples of CTMCs in manufacturing – Equations for CTMC evolution – Markov model of a transfer line. Birth and Death Processes in Manufacturing – Steady state analysis of BD Processes – Typical BD processes in manufacturing.

**UNIT III:**

**Queuing Model:** Notation for queues – Examples of queues in manufacturing systems – Performance measures – Little's result – Steady state analysis of M/M/m queue, queues with general distributions and queues with breakdowns – Analysis of a flexible machine center.

**UNIT IV:**

**Queuing Networks:** Examples of QN models in manufacturing – Little's law in queuing networks – Tandem queue – An open queuing network with feedback – An open central server model for FMS – Closed transfer line – Closed server model – Garden Newell networks.

**UNIT V:**

**Petrinets:** Classical Petri Nets – Definitions – Transition firing and reachability – Representational power – properties – Manufacturing models.
Stochastic Petri Nets – Exponential timed Petri Nets – Generalized Stochastic Petri Nets – modeling of KANBAN systems – Manufacturing models.

**REFERENCES:**

1. Performance Modelling of Automated Manufacturing Systems/ Viswanadham, N and Narahari, Y/ Prentice Hall of India, New Delhi, 1994
2. Probability and Statistics with Reliability, Queuing and Computer Science Applications/ Trivedi, K.S./ Prentice Hall, New Jersey, 1982.
3. Fundamentals of Mathematical Statistics/ Gupta S.C. & Kapoor V.K./ 3rd Edition, Delhi, 1988

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## NUMERICAL METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS
**(Open Elective – I)**

**Course objectives:**

1. To explain Ordinary differential equations of first order. Applications and numerical methods.
2. To explain Ordinary differential equations of higher order. Applications and numerical methods.
3. To explain Systems of ordinary differential equations and their numerical methods.
4. To explain Laplace transform.
5. To explain Partial differential equations and their applications.
6. To formulate the basic concepts of the course

**Course outcomes:**

1. Apply the fundamental concepts of Ordinary Differential Equations and Partial Differential Equations and the basic numerical methods for their resolution.
2. Solve the problems choosing the most suitable method.
3. Understand the difficulty of solving problems analytically and the need to use numerical approximations for their resolution.
4. Use computational tools to solve problems and applications of Ordinary Differential Equations and Partial Differential Equations.
5. Formulate and solve differential equation problems in the field of Industrial Organisation Engineering.
6. Use an adequate scientific language to formulate the basic concepts of the course.

**UNIT-I**:
Introduction to finite difference formula- Parabolic Equation: Introduction – Explicit finite difference approximation to one dimensional equation Crank – Nicholson implicit method – derivation boundary conditions.

**UNIT-I:**
Alternate direction implicit (ADI) method finite difference in cylindrical and spherical polar co-ordinates.
**Convergence stability and consistency:** Definitions of local truncation error and consistency convergence analysis – stability analysis by matrix method eigen value von Newmann stability methods, global rounding error-local truncation error-lax's equation theorem.

**UNIT-III:**
**Hyperbolic Equations:** Analytical solution of $1^{st}$ order quasi linear equation – numerical integration along a characteristic lax wenderoff explicit method.
**CFI** condition wenderoff implicit approximation – propagation of discontinues – Numerical solution by the method of characteristics.

**UNIT-IV:**
**Elliptic Equations**: Introduction – Finite differences in polar co-ordinates – formulas for derivative near a curved boundary analysis of the discretization error of the five point approximation to polman's equation over a rectangle.

**UNIT-V:**
Systemactic iterative methods for large linerar systems – necessary and sufficient condition for convergence of iterative methods – stones implicit methods.
Finite Element Method: weighted residual method – variations methods – division of the region into elements linear element – Galerkin formuation.

**REFERENCES:**

1. Numerical Solution of partial differential equations, Finite Differences methods/ G.D. Smith/ Brunel University, Clarandon Press Oxford.
2. The Finite Differences Methods in Partial Differential equation/ A.R. Mitchel and D.F. Grnra/ John Wiley.
3. Numerical Methods for Engineers and scientists/Joe D. Hoffman/ Mc Graw Hill

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## PRODUCTION AND OPERATIONS MANAGEMENT
## (Open Elective –I)

**Course objectives:**

1. One of the most critical areas for success in any business enterprise is how Production and Operations are managed.
2. To define what is Operation Management**,** historical development of operations management
3. Standardization – simplification – Speed to market – Introduction to concurrent engineering.
4. To explain the types of values, steps in value engineering – methodology in value engineers.
5. Explain what is Aggregate Planning, Various models of Aggregate Planning – Transportation and graphical models.
6. To discuss what is Scheduling, Types of scheduling, Line of Balance
7. To explain what is Project Management**,** Programming Evaluation Review Techniques (PERT)

**Course outcomes:**

1. After completing the course the participants shall develop an understanding on how to create a production entity with focus on -Production Base Financial (Cost) Performance Technical and Operational capabilities Human Capabilities
2. Student should able to understand the concept Operation Management product development – approaches – concepts in product development – standardization – simplification – Speed to market
3. Able to know methodology in value engineers.
4. To understand the planning process, Aggregate Planning, Transportation and graphical models.
5. To know the concept of Forward and Backward Scheduling – Gantt Charts – Flow shop Scheduling – n jobs and 2 machines, n jobs and 3 machines
6. To understand the concept of Project Management

**UNIT -I**

**Operation Management:** Definition – Objectives – Types of production systems – historical development of operations management – Current issues in operation management.
Product design – Requirements of good product design – product development – approaches – concepts in product development – standardization – simplification – Speed to market – Introduction to concurrent engineering.

**UNIT – II**

**Value Engineering:** objective – types of values – function & cost – product life cycle- steps in value engineering – methodology in value engineers – FAST Diagram – Matrix Method. Location – Facility location and layout – Factors considerations in Plant location- Comparative Study of rural and urban sites – Methods of selection plant layout – objective of good layout – Principles – Types of layout – line balancing.

**UNIT - III**

**Aggregate Planning:** definition – Different Strategies – Various models of Aggregate Planning – Transportation and graphical models.
Advance inventory control systems push systems – Material Requirement – Terminology – types of demands – inputs to MRP- techniques of MRP – Lot sizing methods – benefits and drawbacks of MRP –Manufacturing Resources Planning (MRP –II), Pull systems – Vs Push system – Just in time (JIT) philosophy Kanban System – Calculation of number of Kanbans Requirements for implementation JIT – JIT Production process – benefits of JIT.

**UNIT - IV**

**Scheduling**: Policies – Types of scheduling – Forward and Backward Scheduling – Gantt Charts – Flow shop Scheduling – n jobs and 2 machines, n jobs and 3 machines – job shop Scheduling – 2 jobs and n machines – Line of Balance.

**UNIT – V**

**Project Management**: Programming Evaluation Review Techniques (PERT) – three times estimation – critical path – probability of completion of project – critical path method – crashing of simple nature.

**REFERENCES:**


1. Operations Management/ E.S. Buffs/ John Wiley & Sons / 2007
2. Operations Management Theory and Problems/ Joseph G. Monks / Macmillan / McGraw Hill / 3rd Edition.
3. Production Systems Management/ James I. Riggs / John Wiley & Sons.
4. Production and Operations Management/ Chary/ Mc Graw Hill/2004
5. Operations Management/ Richard Chase/ Mc Graw Hill/2006
6. Production and Operation Management / Panner Selvam / PHI.
7. Production and Operation Analysis/ Nahima/ Mc Graw Hill/2004

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## ADVANCED CAD LABORATORY

### COURSE OBJECTIVES:

1. To learn graphics software
2. To perform various CAD operations using software
3. To learn programming for analysis of mechanical elements.

### COURSE OUTCOMES:

Upon successful completion students will be able to:

1. Operate graphics software for various Cad applications
2. Carry out programming for optimization of design
3. Use customized FEM software for real application of CAD

Creation of working drawing, creating geometry, constraining the profile, extracting a part using tools, creating pattern of holes, translating rotating, mirroring, managing the specification tree. Creating sheets and views, creating text and dimensions, creating an assembly, moving components, assembling existing components, creating bill of materials, creating wire frame and surface geometry using generative shape design and sweep tools. Generation of Ferguson‘s cubic surface patches, Bezier surface patches. Coons patches. Import and export of drawing from other software. Linear static analysis, Automatic calculation of rigid body modes, uses specified eigen value shift, lumped and consistent mass matrices. Buckling analysis, Jacobi inverse iteration techniques. Steady state harmonic response, mode superposition method, overall structural and damping, linear dynamic analysis, non linear static analysis, nonlinear dynamic analysis. Steady state heat transfer analysis problems. Transient heat transfer analysis. Familiarity with element library. Defining Boundary conditions, multipoint constraint familiarity with different types of loads. Solution techniques, direct and iterative solver. Results and analysis. Design optimization.

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## Design for Manufacture & Assembly (DFMA)

**COURSE OBJECTIVES:**

1. To introduce the concept of design process and Selection of Materials for design Developments in Material technology
2. Explain the various machining and casting processes design recommendations for product development
3. To learn assembly methodology and automic assembly transfer systems
4. Explain the different types of welding and Design guidelines for manufacturing and assembly to practicing designers
5. To explain the design of manual assembly, DFA methodology, design of insertion operations and time.
6. How to analyze products and be able to improve their manufacturability and lower costs.

**COURSE OUTCOMES:**

1. Various types of materials, suitable materials for product design and various methods of material selection, various mechanical properties of material developments in Material technology
2. To understand the various casting design, machining design, designing of formed components to develop the product.
3. Various design recommendation for permanent joining such as welding, soldering and brazing various design recommendations
4. Student is able to learn assembly methodology and automic assembly transfer systems
5. Student is able to learn DFA methodology, development of manual assembly and automic assembly transfer systems
6. Apply principles of DFA to increase manufacturing efficiency in assembly processes.

**UNIT - I**

**Introduction:** Design philosophy steps in Design process - General Design rules for manufacturability - basic principles of design Ling for economical production - creativity in design. Materials: Selection of Materials for design Developments in Material technology - criteria for material selection - Material selection interrelationship with process selection process selection charts.

**UNIT- II**

**Machining Process**: Overview of various machining processes - general design rules for machining - Dimensional tolerance and surface roughness - Design for machining - Ease - Redesigning of components for machining ease with suitable examples. General design recommendations for machined parts. **Metal Casting**: Appraisal of various casting processes, selection of casting process, - general design considerations for casting - casting tolerances - use of solidification simulation in casting design - product design rules for sand casting.

**UNIT- III**

**Metal Joining**: Appraisal of various welding processes, Factors in design of weldments - general design guidelines - pre and post treatment of welds - effects of thermal stresses in weld joints - design of brazed joints. Forging - Design factors for Forging - Closed dies forging design - parting lines of die5 drop forging die design - general design recommendations. Extrusion & Sheet Metal Work: Design guidelines for extruded sections - design principles for Punching, Blanking, Bending, and Deep Drawing - Keeler Goodman Forming Line Diagram - Component Design for Blanking.

**UNIT-IV**

**Assemble Advantages:** Development of the assemble process, choice of assemble method, assemble advantages social effects of automation.

**Automatic Assembly Transfer Systems**: Continuous transfer, intermittent transfer, indexing mechanisms, and operator - paced free – transfer machine.

**UNIT-V**

**Design of Manual Assembly**: Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time.

**REFERENCES:**

1. Assembly Automation and Product Design/ Geoffrey Boothroyd/ Marcel Dekker Inc., NY, 1992.
2. Engineering Design - Material & Processing Approach/ George E. Deiter/McGraw Hill Intl. 2nd Ed. 2000.
3. Hand Book of Product Design/ Geoffrey Boothroyd/ Marcel and Dekken, N.Y. 1990.
4. Computer Aided Assembly London/ A Delbainbre/.

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## FLEXIBLE MANUFACTURING SYSTEMS

**COURSE OBJECTIVES:**

1. To expose the student to the different types of manufacturing available today such as the Special Manufacturing System, the Manufacturing Cell, and the Flexible Manufacturing System (FMS)
2. To learn the fundamentals of computer assisted numerical control programming and programming languages
3. What is Software for simulation and database of FMS and its application of simulation software
4. The common CAD/CAM data base organized to serve both design and manufacturing.
5. To practice the PLC control devices and CNC operation skills.
6. Explain about the Preventive maintenance karban system, implementation issues

**COURSE OUTCOMES:**

1. Student should able to understand evolution of Manufacturing Systems Introduction to Flexible Automation Systems and Flexible Manufacturing System Design
2. Processing and Quality Assurance Equipment Automated Machining Systems Coordinate Measuring Machine
3. An ability to analyze simulation and database of FMS and its applications
4. Student should able to understand manufacturing data systems data flow and Planning FMS database with fundamentals of CAD/CAM.
5. FMS Computer Hardware, Software, and Communication Networks, NC programming programmable logic control (PLC), Sensory Systems and Actuator devices Servo Systems.
6. To understand the Preventive maintenance and implementation issues

**UNIT- I:**
Introduction to flexible manufacturing systems. Planning and scheduling and control of FMS. Knowledge based scheduling.

**UNIT - II:**
Hierarchy of computer control. Supervisory computer.

**UNIT - III**:
Software for simulation and database of FMS. Specification and selection, trends, application of simulation software.

**UNIT - IV:**
Manufacturing data systems data flow, CAD/CAM considerations. Planning FMS database, just in time characteristics, Pull method, quality small lot sizes, work station loads, close supplier ties, flexible workforce — line flow strategy.

**UNIT - V:**
Preventive maintenance. Karban system, implementation issues.

**REFERENCES:**

1. Hand Book of Flexible Manufacturing Systems/ Jha N K/ Academic Press.
2. Production System l3eyond Large Scale Production/ Talichi Ohno/ Toyota Productivity Press India Pvt. Lid.
3. Flexible Manufacturing Systems/ H K Shivanand/New Age International/2006

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## INDUSTRIAL ROBOTICS

**COURSE OBJECTIVES:**

1. To be familiar with the automation and brief history of robot and applications.
2. To give the student familiarities with the kinematics of robots.
3. To give knowledge about robot end effectors and their design.
4. To learn about Robot Programming methods & Languages of robot.
5. To give knowledge about various Sensors and their applications in robots.
6. To study the basic concepts of robotics and various components of Industrial robots.

**COURSE OUTCOMES:**

1. Students will be equipped with the automation and brief history of robot and applications.
2. Students will be familiarized with the kinematic motions of robot.
3. Students will have good knowledge about robot end effectors and their design concepts.
4. Students will be equipped with the Programming methods & various Languages of robots.
5. Students will be equipped with the principles of various Sensors and their applications in robots
6. Students will gain knowledge in design of robots applicable to industries.

**UNIT - I**

**introduction**: Automation and Robotics, Robot anatomy, robot configuration, motions joint notation work volume, robot drive system, control system and dynamic performance, precision of movement. **Control System and Components:** basic concept and modals controllers control system analysis, robot activation and feedback components. Positions sensors, velocity sensors, actuators sensors, power transmission system.

**UNIT - II**

**Motion Analysis and Control:** Manipulator kinematics, position representation forward transformation, homogeneous transformation, manipulator path control, robot dynamics, configuration of robot controller.

**UNIT - III**

**End Effectors:** Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design. SENSORS: Desirable features, tactile, proximity and range sensors, uses sensors in robotics.

**Machine Vision:** Functions, Sensing and Digitizing-imaging, Devices, Lighting techniques, Analog to digital single conversion, image storage, Image processing and Analysis-image data reduction, Segmentation feature extraction. Object recognition, training the vision system, Robotics application.

**UNIT - IV**

**Robot Programming:** Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SINONAL AND DELAY commands, Branching capabilities and Limitations. **ROBOT LANGUAGES**: Textual robot Languages, Generation, Robot language structures, Elements in function.

**UNIT - V**

**Robot Cell** DESGIN AND CONTROL: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work design, Work and control, Inter locks, Error detect ion, Work wheel controller. **Robot Application**: Material transfer, Machine loading/unloading. Processing operation, Assembly and Inspection, Feature Application.

**REFERENCES:**


1. Industrial Robotics / Groover M P /Pearson Edu.
2. Introduction to Robotic Mechanics and Control by JJ Craig, Pearson, 3rd edition.
3. Robotics / Fu K S/ McGraw Hill.
4. Robotic Engineering / Richard D. Klafter, Prentice Hall
5. Robot Analysis and Intelligence / Asada and Slotine / Wiley Inter-Science.
6. Robot Dynamics & Control – Mark W. Spong and M. Vidyasagar / John Wiley & Sons (ASIA) PteLtd.
7. Robotics and Control / Mittal R K & Nagrath I J / TMH

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**4 - 4**

## INTELLIGENT MANUFACTURING SYSTEMS
## (Core Elective-III)

**COURSE OBJECTIVES:**

1. To understandIntelligent Manufacturing System Components, System Architecture and Data Flow, System Operation
2. To know Components of Knowledge Based Systems - Basic Components of Knowledge Based Systems
3. To know Concept of Artificial Intelligence and Applications in Manufacturing.
4. Automated Process Planning Generative Approach and KBSES
5. Group Technology: Models and Algorithms Visual Method, Coding Method
6. To explain about the manufacturing systems apllications

**COURSE OUTCOMES:**

1. Students will be understandIntelligent Manufacturing System Operation
2. Students will learn Comparison of Knowledge Representation Schemes
3. To learn Machine Learning , Applications in Manufacturing
4. What is Manufacturing system design Structure of the KRSES.
5. To know what is Models and Algorithms Visual Method
6. Students will be able to know about the manufacturing systems apllications

**UNIT I:**

Computer Integrated Manufacturing Systems Structure and functional areas of CIM system, - CAD, CAPP, **CAM,** CAQC, ASRS. Advantages of CIM. Manufacturing Communication Systems - MAP/TOP, OSI Model, Data Redundancy, Top- down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing System Components, System Architecture and Data Flow, System Operation.

**UNIT II:**

Components of Knowledge Based Systems - Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition.

**UNIT III:**

Machine Learning - Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks - Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing.

**UNIT IV:**

Automated Process Planning - Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning. Knowledge Based System for Equipment Selection (KBSES) - Manufacturing system design. Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approach in KBSES, Structure of the KRSES.

**UNIT V:**

Group Technology: Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation - Similarity Coefficient Method, Sorting- based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology - Group Technology in Automated Manufacturing System. Structure of Knowledge based system for group technology (KBSCIT) — Data Base, Knowledge Base, Clustering Algorithm.

**REFERENCES:**


1. Intelligent Manufacturing Systems/ Andrew Kusiak/Prentice Hall
2. Artificial Neural Networks/ Yagna Narayana/PHI/2006
3. Automation, Production Systems and CIM / Groover M.P./PHI/2007
4. Neural networks: A comprehensive foundation/ Simon Hhaykin/ PHI.
5. Artificial neural networks/ B.Vegnanarayana/PHI
6. Neural networks in Computer intelligence/ Li Min Fu/ TMH/2003
7. Neural networks/ James A Freeman David M S kapura/ Pearson education/2004
8. Introduction to Artificial Neural Systems/Jacek M. Zurada/JAICO Publishing House Ed. 2006.

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**4 - 4**

## SPECIAL MANUFACTURING PROCESS
## (Core Elective-III)

**COURSE OBJECTIVES:**

1. To expose the students to a variety of manufacturing processes in surface treatment, types of surface coating, methods of coating
2. To teach the important effects that manufacturing processes in ceramics, powder preparation, processing of composites
3. To teach fabrication of microelectronic devices, wafer preparation, bonding and packaging techniques and design in micro electronic
4. To explain nano manufacturing techniques and micro machining
5. To teach the techniques for rapid manufacturing, methods and its applications
6. To expose the students to a variety of manufacturing processes including their typical use and capabilities

**COURSE OUTCOMES:**

1. Students will understand and appreciate the latest manufacturing process and apply while working in industry
2. To learn the manufacturing process Powder preparations, consolidation, drying, sintering, hot compaction, Area of application, finishing of ceramics
3. To understand the fabrication process in micro electronic device and CA design in microelectronic devices
4. To understand Nano manufacturing techniques and micromachining, High Speed Machining and hot machining
5. How to learn the methods of Rapid tooling techniques and its applications
6. Students will understand and appreciate the latest manufacturing process and apply while working in industry.

**UNIT- I**

**Surface Treatment:** Scope, Cleaners, Methods of cleaning, Surface coating types, and ceramic and organic methods of coating, economics of coating. Electro forming, Chemical vapor deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.

**UNIT- II**

**Processing of Ceramics:** Applications, characteristics, classification .Processing of particulate ceramics, Powder preparations, consolidation, Drying, sintering, Hot compaction, Area of application, finishing of ceramics. Processing of Composites: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

**UNIT- III**

**Fabrication of Microelectronic Devices**:
Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in micro electronics, surface mount technology, Integrated circuit economics.

**UNIT - IV**

**E-Manufacturing:** Nano manufacturing techniques and micromachining, High Speed Machining and hot machining

**UNIT -V**

**Rapid Prototyping:** Working Principles, Methods, Stereo Lithography, Laser Sintering, Fused Deposition Method, Applications and Limitations, Rapid tooling, Techniques of rapid manufacturing

**REFERENCES:**

1. Manufacturing Engineering and Technology *I* Kalpakijian / Adisson Wesley, 1995.
2. Process and Materials of Manufacturing / R. A. Lindburg / 1th edition, PHI 1990.
3. Microelectronic packaging handbook / Rao. R. Thummala and Eugene, J. Rymaszewski / Van Nostrand Renihold,
4. MEMS & Micro Systems Design and manufacture / Tai — Run Hsu / TMGH
5. Advanced Machining Processes / V.K.Jain / Allied Publications.
6. Introduction to Manufacturing Processes / John A Schey *I* Mc Graw Hill.

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**4 - 4**

## DESIGN OPTIMIZATION
## (Core Elective-III)

**COURSE OBJECTIVES:**

1. To expose the students to, principles of optimization and optimization techniques
2. To teach Technique of unconstrained minimization
3. To explain direct methods and indirect methods using penalty function
4. What are engineering applications, structural-design application axial and transverse loaded member
5. What are theApplications dynamics for two degree freedom system
6. To learn about the optimization techniques and application in mechanisms.

**COURSE OUTCOMES:**

1. Students will understand optimization techniques
2. To learn the, Pattern and Gradient search methods, interpolation methods
3. To learn equality and inequality constraints
4. Students will learrn Design of shafts and torsion members, design optimization of springs.
5. Application in mechanisms
6. Students will be able to know about the optimization techniques and Application in mechanisms.

**UNIT- I**:

General Characteristics of mechanical elements, adequate and optimum design, principles of optimization, formulation of objective function, design constraints, classification of optimization problems. Single and multivariable optimization techniques

**UNIT- II:**

Technique of unconstrained minimization. Golden section, Random, Pattern and Gradient search methods, interpolation methods, equality and inequality constraints.

**UNIT-III:**

Direct methods and indirect methods using penalty function, Lagrange multipliers, Geometric programming, stochastic programming, Genetic algorithms

**UNIT-IV**:

Engineering applications, structural-design application axial and transverse loaded members for minimum cost, maximum weight. Design of shafts and torsion members, design optimization of springs.

**UNIT-V**:

Dynamics applications for two degree freedom system. vibration absorbers. Application in mechanisms.

**REFERENCES:**


1. Engineering Optimization -Theory and Practice/ Singerusu S. Rao/ New Age.
2. Optimum Design of Mechanical elements/ Johnson Ray C/ Wiley, John & Sons
3. Genetic Algorithms in search, Optimization and Machine/ Goldberg D. E. Addison/Wesley / NewYork..
4. Optimization for Engineering Design Algorithms and Examples/ Kalyanamoy Deb/Prentice Flail of India.
5. Introduction to Optimum Design/Jasbir S. Arora/ Academic Press/ Everest/ 3rd Edition

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## ADVANCED MECHATRONICS
## (Core Elective-IV)

**COURSE OBJECTIVES:**

1. Needs, Context and Systems- Describe, investigate and analyze complex engineering systems and associated issues (using systems thinking and modeling techniques)
2. Problem Solving and Design- Develop creative and innovative solutions to engineering problems- Develop and operate within a hazard and risk framework appropriate to engineering activities
3. Analysis- Comprehend and apply advanced theory-based understanding of engineering fundamentals and specialist bodies of knowledge in the selected discipline area to predict the effect of engineering activities.
4. Professional Practice- Understand the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the specific discipline
5. Research- Be aware of knowledge development and research directions within the engineering discipline.
6. To learn the Mechatronics systems such as controls and drives, real time interfacing, data acquisition system, sensors for condition monitoring, mechanical controlling, automated manufacturing.

**COURSE OUTCOMES:**
Upon successful completion of this course you should be able to:

1. Demonstrate knowledge about the development and research directions in sensing, perception and actuation technologies.
2. Develop creative and innovative solutions to an automation problem and anticipate the financial and social consequences of any intended action.
3. Comprehend and apply advanced theory-based understanding of intelligent systems in designing automated industrial solutions in the context of new and emerging manufacturing technologies.
4. Describe mechanical design within the context of intelligent solutions and assess the interaction between sensing and actuation in designing intelligent mechanical systems.
5. Use experience with practical industrial examples of intelligent systems to assess the application of theoretical knowledge to industrial situations and demonstrations.
6. Students will be able to design a Mechatronics system such as pick and place robot, car park barriers, car engine management and bar code reader.

**UNIT-I**

Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion , force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

**UNIT-II**

Solid state electronic devices, PN junction diode, BJT, FET, DIA and TRIAC. Analog signal conditioning, amplifiers, filtering. Introduction to MEMS & typical applications.

**UNIT-III**

Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems: Mechanical actuating systems and electrical actuating systems.

**UNIT-IV**

Digital electronics and systems, digital logic control, micro processors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

**UNIT-V**

System and interfacing and data acquisition, DAQS, SCADA, A to D and D to A conversions; Dynamic models and analogies, System response. Design of mechatronics systems & future trends.

**REFERENCES:**


1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran & GK Vijaya Raghavan/WILEY India Edition/2008
2. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005.
3. Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
4. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
5. Mechatronics System Design / Devdas shetty/Richard/Thomson.
6. Mechatronics/M.D.Singh/J.G.Joshi/PHI.
7. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. $4^{th}$ Edition, Pearson, 2012 W. Bolton
8. Mechatronics – Principles and Application Godfrey C. Onwubolu, Wlsevier, 2006 Indian print

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**4 - 4**

## DESIGN AND MANUFACTURING OF MEMS AND MICRO SYSTEMS
## (Core Elective-IV)

**COURSE OBJECTIVES:**

1. To gain fundamental understanding of standard micro fabrication techniques and issue surrounding them.
2. To know major classes, components and applications of MEMS.
3. To demonstrate fundamental principles behind the operation of devices/systems.
4. To apply knowledge of micro fabrication techniques and applications to the design and manufacturing of an MEMS device or a micro system.
5. Basic equations in Continuum Fluid dynamics, Laminar Fluid Flow in Circular Conduits
6. To know basic concept of Diffusion and oxidation, chemical and physical vapor deposition, Etching, Bulk micro manufacturing, Surface Micromachining, The LIGA Process

**COURSE OUTCOMES:**

1. Students will be able to understand working principles of currently available micro sensors, actuators, motors, valves, pumps and fluids used in Microsystems.
2. Students will be able to use materials for common micro components and devices.
3. Students will be able to choose a micromachining technique for a specific MEMS fabrication process.
4. Students will be able to understand the basic principles and applications of micro fabrication processes.
5. Students will be able to understand the basic concept of Continuum Fluid dynamics, Laminar Fluid Flow in Circular Conduits
6. To know the concept of the LIGA Process

**UNIT I:**

**Overview and Working Principles of MEMS and Microsystems**
MEMS & Microsystems, Evolution of Micro fabrication, Microsystems & Microelectronics, Microsystems & Miniaturization, Applications of MEMS in Industries, Micro sensors, Micro actuation, MEMS with Micro actuators Micro accelerometers, Micro fluidies.

**UNIT II:**

**Engineering Science for Microsystems Design and Fabrication:**
Atomic structure of Matter, Ions and Ionization, Molecular Theory of Mater and Intermolecular Force, Doping of Semiconductors, The diffusion Process, Plasma Physics, Electrochemistry, Quantum Physics

**UNIT III:**

**Engineering Mechanics for Microsystems Design:**
Static Bending of thin Plates, Mechanical Vibration, Thermo mechanics Fracture Mechanics, Thin-Film Mechanics, Overview of Finite Element Stress Analysis

**UNIT IV:**

**Thermo Fluid Engineering & Microsystems Design:**
Overview of Basics of Fluid Mechanics in Macro and Meso scales, Basic equations in Continuum Fluid dynamics, Laminar Fluid Flow in Circular Conduits, Computational Fluid Dynamics, Incompressible Fluid Flow in Micro conduits, Fluid Flow in Sub micrometer and Nano scale, Overview of Heat conduction in Solids, Heat Conduction in Multilayered Thin films and in solids in sub micrometer scale, Design Considerations, Process Design Mechanical Design, Mechanical Design using FEM, Design of a Silicon Die for a Micro pressure Sensor.

**UNIT V:**

**Materials for MEMS & Microsystems and Their Fabrication:**

Substrates and Wafers, Active substrate materials, Silicon as a substrate material, Silicon Compounds, Silicon Piezoresistors, Gallium Arsenide, Quartz, Piezoelectric Crystals and Polymers, Photolithography, Ion implantation, Diffusion and oxidation, chemical and physical vapor deposition, Etching, Bulk micro manufacturing, Surface Micromachining, The LIGA Process

**REFERENCES:**


1. MEMs & Microsystems: Design & Manufacture/ Tai-Ran Hsu/Tata Mc-Graw Hill., ed./2002
2. An Introduction to Microelectromechanical Systems Engineering/ Maluf, M./ Artech House, Boston, 2000
3. Micro robots and Micromechanical Systems/ Trimmer, W.S.N/ Sensors & Actuators, vol19, no.1989.
4. Applied Partial Differential Equations/ Trim, D.W/ PWS-Kent Publishing/ Boston 1990.
5. Fundamentals of Microfabrication. Madou, M/ CRC Press, Boca Raton, 1997.
6. The Finite Element Method in Thermomechanics/ Hsu, T.R / Alien & Unwin, London.

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**4 - 4**

## FUZZY LOGIC AND NEURAL NETWORKS
## (Core Elective-IV)

**COURSE OBJECTIVES:**

1. To Understand the fundamentals of fuzzy logic, its relative principles.
2. To Learn the concepts of neural networks, hybrid intelligence.
3. To Identifying the real time applications.
4. To know the Basic concepts of Neural Network
5. Network Training Applications in Mechanical Engineering –Fuzzy –Neural

**COURSE OUTCOMES:**

1. Students will be able to: Identify the potential areas of application of fuzzy logic
2. To know Design fuzzy logic and genetic algorithm.
3. Apply the concepts of fuzzy control to real time systems.
4. Students will be able to classification Models optimization models.
5. To learn Knowledge based approaches-applications in Mechanical Engineering

**UNIT-I**

Knowledge and Processing – Knowledge and Intelligence- logic frames- production systems. Fundamentals of Fuzzy logic-characteristics of fuzzy logic and systems-Fuzzy sets-Fuzzy number-Equality of fuzzy sets- Empty Fuzzy set –Fuzzy point-universal Fuzzy set. Operations on Fuzzy sets-Intersection-union –complement.

**UNIT-II**

Fuzzy Relations-classical N-Array Relation-Reflexivity-Anti reflexivity-symmetricity –Transitivity-Equivalence-Binary fuzzy relations, operation on Fuzzy relations-Intersection-union-projection-Cartesian product.

**UNIT-III**

Fuzzy Implications, Translation rules, Triangular norms, Triangular conorm, Fuzzy Rule base system, Fuzzy logic controller, Defuzzification Methods, Fuzzy logic applications-prevention of Road accidents-control room temperature-Robot control system-domestic applications-Industrial applications.

**UNIT-IV**

Basic concepts of Neural Network-Processing units-connection between units-output rules- Network topologies-paradigms of learning –perception, Back-propagation, classification Models-Association Models, optimization models.

**UNIT-V**

Rule Based Neural Networks-Network Training –Application of Neural Network in Mathematical Modeling-Knowledge based approaches-applications in Mechanical Engineering –Fuzzy –Neural, example, Neuro –Fuzzy examples-Intelligence in Automation.

**REFERENCES:**

1. Intelligent Control Fuzzy Logic Applications/ Clarence W.de Silva/ CRS Press,1995.
2. Fuzzy logic &Neural Networks/ Chennakesava R. Alavala/ New Age International,2008
3. Fuzzy Logic with engineering Applications/ Timothy J. Ross/ Mc Graw Hill Inc., 1995.
4. Neural Networks in Computer Intelligence/ Limin Fu / Tata McGraw Hill Publishing Company Ltd.,2003
5. Stamations and Understanding Neural Networks and Fuzzy Logic/ V. Karthalopoulos Basic concepts Applications, IEE Neural Networks Council PHI 2001.

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**ENGINEERING RESEARCH AND METHODOLOGY**
**(Open Elective-II)**

**COURSE OBJECTIVES:**

1. The main objectives of this course are to help students:
2. To use information systems effectively.
3. To identify a research problem.
4. To write a critical review of the relevant literature Literature Survey
5. To choose and apply an appropriate experimental design to a particular research problem, if required.
6. To understand and apply a range of standard techniques for instrumentation and data acquisition.
7. To develop and write a research proposal for their discipline area.
8. To prepare a well written and concise research thesis or report.

**COURSE OUTCOMES:**
At the completion of the subject, students should be able to:

1. Devise strategic research plan to solve a research problem
2. Conduct literature survey for a given research problem Need of Review, Guidelines for Review, Record of Research Review.
3. Analyze and interpret data gathered from field studies or experiments
4. To propose and justify an appropriate research plan for the chosen research problem Write effective research report
5. Recognition of the need for and an ability to engage in lifelong learning and development
6. To Write effective research report

**UNIT-I**

**Research Methodology:** Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research and Scientific Method, Important of Research Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general.
**Defining the Research Problem:** Definition of Research Problem, Problem Formulation, Necessity of Defining the Problem, Technique involved in Defining a Problem.

**UNIT-II:**

**Literature Survey:** Importance of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. **Literature Review:** Need of Review, Guidelines for Review, Record of Research Review.

**UNIT-III:**

**Research Design:** Meaning of Research Design, Need of Research Design, Feature of a Good Design, Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes.

**UNIT-IV:**

**Data Collection**: Exploring the data, Description and Analysis of Data, Sample Design and Sampling, Role of Statistics for Data Analysis, Functions of Statistics, Estimates of Population, Parameters, Parametric V/s Non Parametric methods, Descriptive Statistics, Points of Central tendency, Measures of Variability, Measures of relationship, Inferential Statistics-Estimation, Hypothesis Testing, Use of Statistical software. **Data Analysis:** Deterministic and random data, Uncertainty analysis, Tests for significance: Chi-square, student's'test, Regression modeling, Direct and Interaction effects, ANOVA, F-test, Time Series analysis, Autocorrelation and Autoregressive modeling.

**UNIT-V:**

**Research Report Writing**: Format of the Research report, Style of writing report, References/Bibliography/Webliography, Technical paper writing/Journal report writing. **Research Proposal Preparation:** Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

**REFERENCES:**


1. C.R Kothari, Research Methodology, Methods & Technique; New Age International Publishers, 2004
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011
3. Y.P. Agarwal, Statistical Methods: Concepts, Application and Computation, Sterling Publs., Pvt., Ltd., New Delhi, 2004
4. Vijay Upagade and Aravind Shende, Research Methodology, S. Chand & Company Ltd., New Delhi, 2009
5. P. Ramdass and A. Wilson Aruni, Research and Writing across the Disciplines, MJP Publishers, Chennai, 2009

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**QUALITY ENGINEERING IN MANUFACTURING**
**(Open Elective-II)**

**COURSE OBJECTIVES:**

1. Understand the types of factors and principles of Quality Loss Function.
2. Understand the robust design methodology in solving practical engineering problems.
3. To Comprehend the various quality control tools.
4. To know Typical test strategies, better test strategies, efficient test strategies, steps in designing, conducting and analyzing an experiment
5. To know concept of Six sigma DMAIC methodology
6. To learn the concept of Quality Value and Engineering

**COURSE OUTCOMES**
Students will be able to:
1. Value the concept of quality, use quality tools and obtain the quality loss.
2. Utilize the analytical techniques to find out the variation in the data and obtain optimal results.
3. Select and use the proper orthogonal arrays in designing, conducting and analyzing the experiments.
4. Student will be able to understand designing, conducting and analyzing an experiment
5. To learn the concept of Six sigma DMAIC methodology
6. To know the basic concepts of Quality Value and Engineering

**UNIT - I**

**Quality Value and Engineering:** An overall quality system, quality engineering in production design, quality engineering in design of production processes. Loss Function and Quality Level: Derivation and use of quadratile loss function, economic consequences of tightening tolerances as a means to improve quality, evaluations and types tolerances.(N-type,S-type and L-type)

**UNIT II:**

**Tolerance Design and Tolerancing:** Functional limits, tolerance design for N-type. L-type and S-type characteristics, tolerance allocation fbr multiple components. Parameter and Tolerance Design: Introduction to parameter design, signal to noise ratios, Parameter design strategy, some of the case studies on parameter and tolerance designs.

**UNIT – III**

**Analysis of Variance (ANOVA):** Introduction to ANOVA, Need for ANOVA, NO-way ANOVA, One-way ANOVA, Two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

**UNIT - IV**

**Orthogonal Arrays:** Typical test strategies, better test strategies, efficient test strategies, steps in designing, conducting and analyzing an experiment. Interpolation of Experimental Results: Interpretation methods, percent contributor, estimating the mean.

**UNIT - V**

**Six Sigma and the Technical System:** Six sigma DMAIC methodology, tools for process improvement, six sigma in services and small organizations, statistical foundations, statistical methodology.

**REFERENCES:**

1. Taguchi Techniques for Quality Engineering / Phillip J. Ross / McGraw Hill/ Intl. II Edition, 1995.
2. Quality Engineering in Production systems *I* G. Taguchi, A. Elsayed et al **/** Mc.Graw Hill Intl.Edition, 1989**.**
3. Taguchi Methods explained: Practical steps to Robust Design **/** Papan P. Bagchi *I* Prentice Hall Pvt. Ltd., New Delhi.

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## ADVANCED COMPUTER AIDED MANUFACTURING LAB

### COURSE OBJECTIVES:

1. To impart knowledge on NC programming of different processes. To introduce to machine set up of turning and milling machines.

2. To learn about robot programming languages and robot simulation.

3. To introduce simulation of manufacturing systems using CAM software to generate route sheets, process sheets etc.

### COURSE OUTCOMES:

Upon successful completion students will be able to:

1. Work on CAM software to generate NC programming, robotic simulation, various reports etc,.
2. Features and Selection of CNC turning and milling centers. Practice input programming and operation of CNC turning machines, subroutine techniques and use of cycles.

3. Practice in part programming and operating a machining center, tool planning and selection of sequences of operations, tool setting on machine,

Features and selection of CNC turning and milling centers. Practice in part programming and operation of CNC turning machines, subroutine techniques and use of cycles. Practice in part programming and operating a machining center, tool Joining and selection of sequences of operations, tool setting on machine, practice in APT based NC programming. Practice in Robot programming and its languages. Robotic simulation using software. Robot path control, preparation of various reports and route sheets, Simulation of manufacturing system using CAM software, controller operating system commands.