

Important

Academic Rules

Scheme of

Studies & Syllabus



M.Tech. – Mechanical Engineering
(Effective from 2009-2010)



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ABBREVIATIONS/DEFINITIONS

- "AC" means, Academic Council of the University.
- "BOM" means, the Board of Management of the University.
- "BOS" means, the Board of Studies of the Department.
- "CAU/AUC-option" CAU/AUC means change from Credit to Audit option / change from Audit to Credit option
- "Class/Course Committee" means, the Class/Course Committee of a class/course.
- "Course" means, a specific subject usually identified by its course-number and course-title, with a specified syllabus/course-description, a set of references, taught by some teacher(s)/course- instructor(s) to a specific class (group of students) during a specific academic-term/semester/year.
- "COE" means, the Controller of Examinations
- "Course Instructor" means, the teacher or the Course Instructor of a Course.
- "Curriculum" means the set of Course-Structure and Course-Contents.
- "DAA" means, the Dean of Academic Affairs.
- "DAAB" means Departmental Academic Appeals Board.
- "DEC/PEC" means Dissertation Evaluation Committee/Project Evaluation committee.
- "Department" means a group in the University devoted to a specific discipline also called a School. Department and School are used interchangeably.
- "DSA" means, Dean Student Affairs.
- "Faculty Advisor/Class Counsellor" means, the Faculty Advisor or the Panel of Faculty Advisors, in a Parent Department, for a group (admission-batch) of students. Also known as Class Counsellor.
- "DRPC" means Doctoral Research Programme Committee
- "Grade Card" means the detailed performance record in a term/semester/year/ programme.
- "He" means both genders "he" and "she"; similarly "his" and/or "him" includes "her" as well, in all the cases.
- "HOD" means, the Head of the Department.
- "MET" means Make-up End Term
- "MES" means Make-up End semester
- "MEY" means Make-up End Year
- "MLC" means Mandatory Learning Course.
- "Parent Department" or "Degree Awarding Department" means, the department that offers the degree programme that a student undergoes.
- "Project Guide" means, the faculty who guides the Major Project of the student.
- "RB" means Research Board
- "RPAC" means Research Progress Assessment Committee
- "Regulations" means, set of Academic Regulations.
- "TEC" means Thesis Evaluation Committee
- "University" means, Lingaya's University, Faridabad (LU)
- "VC" means, the Vice Chancellor, Lingaya's University, Faridabad.

CODE OF CONDUCT AND ETHICS FOR STUDENTS

1. Wear decent dress respecting his/her modesty as well as that of others.
2. Expected to respect and show regard for teachers, staff and fellow students.
3. Inculcate civic sense and sensitivity for environment protection.
4. Not to resort to collection of funds for any use without written permission of VC.
5. To exhibit exemplary behaviour, discipline, diligences, and good conduct and are a role model to other students.
6. Not to indulge in offences of cognizable nature.
7. Not to practice casteism, communalism.
8. Not to indulge in any other conduct unbecoming of a professional student of the University.
9. Not to outrage the status, dignity and honour of any person.
10. Not to get involved in physical assault or threat, and use of physical force against any body.
11. Not to expose fellow students to ridicule and contempt that may affect their self esteem.
12. Not to form any kind of student's Union, etc.
13. Not to take active or passive part in any form of strikes/protests.
14. To observe all safety precautions while working.
15. Not to disfigure/damage the University property, building, furniture, machinery, library books, fixtures, fittings, etc. (Damage / loss caused shall have to be made good by the students).
16. Use of mobile/video camera phones is strictly prohibited inside the examination halls, class rooms, laboratories and other working places. LU has the right to confiscate the mobile phones in case of any violation.
17. Not to indulge in ragging/teasing, smoking, gambling, use of drugs or intoxicants, drinking alcohol, rude behavior, and use of abusive language.
18. Not to resort to violence, unruly travel in buses, bullying, threatening and coercing others for undesirable act, such as preventing from attending classes, writing exam. / tests, etc etc.
19. All the students of the LU shall be under the disciplinary control of the VC.
20. Students are deemed to be under the care and guidance of parents. It is obligatory for the former to appraise their progress (given by the CC) to the parents.
21. Fine, if ever imposed, is only to improve discipline and shall be paid promptly.
22. While on campus, students have to take care of their belongings and no responsibility for any loss or damage can be held by the University.
23. Every student shall produce the I-Card on demand, and if lost, get a duplicate issued.
24. The students must attend all lectures, tutorials and practical classes in a course punctually (The attendance will be counted course-wise).
25. To abide by the rules and regulations of the University stipulated from time to time.

IMPORTANT ACADEMIC RULES

M.Tech. - Mechanical Engineering

GENERAL

- The Regulations may evolve and get revised/refined or updated or amended or modified or changed through approvals from the Academic Council from time to time, and shall be binding on all parties concerned, including the Students, Faculty, Staff, Departments, University Authorities and offices. Further, any legal disputes shall be limited to the legal jurisdiction determined by the location of the University and not that of any other parties.
- If, at any time after admission, it is found that a candidate had not in fact fulfilled all the requirements stipulated in the offer of admission, in any form whatsoever, including possible misinformation etc., the matter will be reported to the AC, recommending revoking the admission of the candidate.
- The University reserves the right to cancel the admission of any student at any stage of his study programme in the University on the grounds of unsatisfactory academic performance or indiscipline or any misconduct.
- Medium of Instruction shall be English.

PROGRAMME

- For full-time students, the duration of study shall be a minimum of Six Terms and a maximum of FOUR years. For part-time students, the duration will be a minimum of Nine Terms and a maximum of FIVE years.
- There are three types of student status in the M.Tech. Degree Programme:
 - (a) Full-time student of GATE-Scholarship (FTG)
 - (b) Full-time/Part-time sponsored student from Industry or other Organizations including Educational Institutions (FTS/PTS)
 - (c) Full-time/Part time non-sponsored non-scholarship student (FTN/PTN)
- The course content for an M.Tech. Degree Programme will typically consist of the following components.
 - (a) Two-Letter Grade Courses
 - (i) Compulsory Courses
 - (ii) Programme Core Courses
 - (iii) Elective Courses*
 - (iv) Dissertation
 - (b) Non-Two-Letter Grade Courses
 - (i) Seminar
 - (ii) Teaching Practice
- * Some electives may be pre-requisite for another elective course.
- The exact credits offered for the programme for the above components, the term-wise distribution among them, as well as the syllabi of all postgraduate courses offered by the department are given in the 'Scheme of Studies and Syllabus'.
- The minimum credit requirement for the M.Tech. Degree is 90.

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DISSERTATION

- The Dissertation carries 11 credits and spreads over THREE Terms, (normally during 4th to 6th Terms for full time and 7th to 9th Terms for part time students or as recommended by BOS). The progress of the Dissertation shall be monitored by the guide.
- Under special circumstances a student can be allowed to undertake dissertation work in industry/research laboratory/other University. The place of work has to be approved by AC.
- A candidate shall submit 5 copies of the Dissertation duly recommended by the guide after assessment by the committee to the Chairman, DEC, on or before the specified date. The Report shall be in the format prescribed by the University.
- The earliest date for the submission of dissertation shall be three weeks before the closure of the trimester in which the dissertation work credits have been registered for, and is expected to be completed, or as announced by the DAA.
- Extension of time beyond the announced last date for submission of the Dissertation may be granted by the DAA on recommendation from the HOD.
- The final evaluation is done by a Dissertation Evaluation Committee (DEC) constituted by the pertinent BOS. There shall be an open seminar followed by a viva-voice examination as part of the final evaluation. After the final evaluation, appropriate double-letter grade is recommended to DAA, for necessary action.
- If in the opinion of DEC, the Dissertation needs some minor modifications DEC will report to DAA along with recommended grade. The DAA shall instruct the candidate suitably to incorporate the necessary modifications and to resubmit it to the Chairman, DEC. After such resubmission, the Chairman, DEC will certify that the necessary modifications have been incorporated and recommend to DAA for the acceptance and award of the grade as recommended by DEC.
- The title of the Dissertation shall be indicated in the Transcript.
- The dissertation grades will be considered for TGPA and CGPA calculation.

NON TWO-LETTER GRADE COURSES

- These are courses that must be completed by the student at appropriate time as suggested by the Faculty Advisor. The 'S' grade is awarded for satisfactory completion of the course and 'N' grade is awarded for non-completion of the course. In case 'N' grade is awarded, the student has to re-register for the same course wherein he has no alternative options. However, he can opt for other courses if he has been provided with multiple options. The 'S' and 'N' grades do not carry grade-points and hence not included in the TGPA, CGPA computations.

ASSOCIATION

- Every Post Graduate student of the University shall be associated with the Parent Department, throughout his study period.
- The schedule of academic activities for a term, including the dates of registration, mid-term examinations, end-term examination, inter-term vacation, etc. shall be referred to as the Academic Calendar of the term, and announced at least two weeks before the closing date of the previous term.

PRE-REGISTRATION

- In order to facilitate proper planning of the academic activities of a term, it is essential for the students to declare their intent to register for a course well in advance, before the actual start of the academic session, through the process of Pre-Registration, which is mandatory for all those students of second or subsequent term who propose to deviate from recommended scheme of studies.
- Pre-registration is an expression of intention of a student to pursue particular course(s) in the next term. It is an information for planning for next term. Every effort will be made to arrange for a course opted by the student. However, it is not obligatory on the part of the university to offer the course(s) and no course may be offered if the number of students opting for the course is less than 15 or 25 percent of the admission strength whichever is less.
- If a student fails to pre-register it will be presumed that he will follow suggested normal scheme of studies provided that he is progressing at a normal pace. For remaining students the HOD of the parent department will plan for courses as per the convenience of the department.

REGISTRATION TO COURSES

- Every Student after consulting his Faculty-Advisor is required to register for the approved courses with the HOD of parent department at the commencement of each term on the days fixed for such registration as notified in the academic calendar.
- A student shall register for courses from amongst the courses being offered in the term keeping in mind the minimum and maximum credits allowed for a degree and other requirements i.e. pre-requisite, if any, TGPA and CGPA after consulting the Faculty Advisor. No registration will be valid without the consent of HOD of the parent department.
- A student will be permitted to register in the next term as per the suggested normal scheme only if he fulfills the following conditions:
 - (a) Satisfied all the Academic Requirements to continue with the programme of studies without termination.
 - (b) Cleared all University, library and hostel dues and fines (if any) of the previous term.
 - (c) Paid all required advance payments of the University and hostel for the current term.

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- (d) Not been debarred from registering on any specific ground by the University.
- The students will be permitted to register for course(s) being offered in a term other than his normal suggested scheme provided that the time table permits.
- The registration in the critical cases will be done as per the priority given below:
 - (a) Fulfillment of minimum credit requirement for continuation,
 - (b) The completion of programme in minimum period needed for degree, (Those who need to improve TGPA/CGPA)
 - (c) The fulfillment of pre-requisite requirement of courses.
- Students who do not register on the day announced for the purpose may be permitted LATE REGISTRATION up to the notified day in academic calendar on payment of late fee.
- REGISTRATION IN ABSENTIA will be allowed only in exceptional cases with the approval of the DAA after the recommendation of HOD through the guardian of the student.
- Credits will be awarded in registered courses only.

TEACHING PRACTICE

- A student is required to do two courses (one one-credit course and the other a two-credit course) for Teaching Practice under the guidance of HOD. Here the student is required to be engaged in teaching of two UG courses of his choice each for two hours per week in any of the two terms during the programme.

REGISTRATION- REVISION

- A student has the option to ADD courses for registration till the date specified for late registration in the Academic Calendar.
- On recommendation of the Teaching Department as well as the Parent Department, a student has the option to DROP courses from registration until two weeks after the commencement of the classes in the term, as indicated in the Academic Calendar.
- A student can register for auditing a course, or a course can be converted from credit to audit or from audit to credit, with the consent of the Faculty Advisor and Course Instructor within two weeks after the commencement of the classes in the term as indicated in the Academic Calendar. However, CORE Courses shall not be available for audit.

ATTENDANCE REQUIREMENTS

- University academic programmes are based primarily on the formal teaching-learning process. Attendance in classes, participating in classroom discussions and participating in the continuous evaluation process are the most essential requirements of any academic programme.

- Attendance will be counted for each course scheduled teaching days as per the academic calendar.
- The attendance requirement for appearing in end term examination shall be a minimum of 75% of the classes scheduled in each course.

LEAVE OF ABSENCE

- The leave of absence must be authorized as per regulations.
- A student short of attendance in a course (less than needed after leave of absence and condonation by VC) will be awarded 'FF' grade in the course.
- All students must attend all lecture, tutorial and practical classes in a course. The attendance will be counted course wise.
- To account for approved leave of absence e.g. representing the University in sports, games or athletics; professional society activities, placement activities, NCC/NSS activities, etc. and/or any other such contingencies like medical emergencies, etc., the attendance requirement shall be a minimum of 75% of the classes scheduled in each course to appear in the examination.
- A student with less attendance in a course during a trimester, in lectures, tutorials and practicals taken together as applicable, shall be awarded 'FF' grade in that course, irrespective of his academic performance, and irrespective of the nature of absence.
- If the period of leave is more than three days and less than two weeks, prior application for leave shall have to be submitted to the HOD concerned, with the recommendation of the Faculty-Advisor, stating fully the reasons for the leave requested, along with supporting documents.
- If the period of leave is two weeks or more, prior application for leave shall have to be made to the DAA with the recommendations of the Faculty-Advisor, HOD concerned stating fully the reasons for the leave requested, along with the supporting documents. The DAA may, on receipt of such application, grant leave or decide whether the student be asked to withdraw from the course for that particular term because of long absence.
- If a student fails to apply and get sanction for absence as in the two cases above, his parent/guardian may apply to the VC with reasons duly recommended by the faculty advisor, HOD and DAA and explain in person to the VC the reasons for not applying in time. The VC will consider on merit and decide to grant the leave or withdrawal from the course for that particular term subject to any condition that he may like to impose. The decision of the VC shall be final and binding.

ABSENCE DURING EXAMINATIONS

- A student who has been absent during Mid-term Examination due to illness and/or any exigencies may give a request for make-up examination within one week after the Mid-term Examination to the HOD with necessary supporting documents in person. The HOD may

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consider such requests depending on the merits of the case, and after consultation with the course instructor, may permit the Make-up examination for the Student concerned. However, no makeup examination will be permitted if the attendance in the course is less than 60% till the date of examination.

- In case of absence from End-term Examination of a course(s) on Medical ground and/or other special circumstances, the student can apply for award of 'I' grade in the course(s) with necessary supporting documents and certifications by an authorized person to the HOD within one week after the End-term Examination. The HOD may consider the request, depending on the merit of the case, and after consultation with the Course(s) Instructor(s)/ faculty advisor permit the MET Examination for the student concerned. The student may subsequently complete all course requirements within the date stipulated by BOS (which may possibly be extended till first week of trimester under special circumstances) and 'I' grade will then be converted to an appropriate Double-letter grade, as per Clause No: G5.9. All the details of such a decision with date of finalizing the grade shall be communicated to DAA. If such an application for the 'I' grade is not made by the student then a double-letter grade will be awarded based on his term performance.

COURSE CREDIT ASSIGNMENT

- Every Course comprises of specific Lecture-Tutorial-Practical (L-T-P) Schedule. The credits for various courses are shown in the Schemes of Studies and syllabus.
- The Academic Performance Evaluation of a Student shall be according to a Letter Grading System, based on the Class Performance Distribution.
- The double-letter grade (AA, AB, BB, BC, CC, CD, DD, FF) indicates the level of academic achievement, assessed on a decimal (0-10) scale.

Letter-Grades and Grade-Points:

LETTER-GRADE	GRADE-POINTS	REMARKS
AA	10	
AB	9	
BB	8	
BC	7	
CC	6	
CD	5	
DD	4	
FF	0	Fail
I	-	Incomplete
U	-	Audited
W	-	Withdrawal
S	-	Satisfactory
N	-	Unsatisfactory

DESCRIPTION OF GRADES

- An 'AA' grade stands for outstanding performance, relative to the class which may include performance with previous batches. The Course Instructor is supposed to take utmost care in awarding of this highest double-letter grade.
- The 'DD' grade stands for marginal performance and is the minimum passing double-letter grade.
- The 'FF' grade denotes very poor performance, i.e. failure in a course, and the Course Instructor is supposed to take utmost care while awarding this lowest double-letter grade.
- A student, who obtains 'FF' grade in a core course, has to repeat (re-register) that core course, in subsequent trimesters/sessions whenever the course is offered, until a passing grade is obtained. However, for an elective course in which 'FF' grade has been obtained, the student may either repeat the same course, or register for any other elective course.
- An 'I' grade denotes incomplete performance in any course due to absence at the end term examination (see also Clause No: G7.4). When the 'I' grade is converted to a regular double letter grade, a penalty of ONE Grade-Point is imposed, by awarding the double-letter grade that is immediately below the one that the student would have otherwise received except when the student has 95% attendance record in the subject concerned. For example, if on the basis of the performance including MET Examination, a student gets AB grade, he will be awarded BB grade if not under exception rule.
- 'U' grade is awarded in a course that the student opts to register for audit. It is not mandatory for the student to go through the entire regular process of evaluation in an audit course. However, the student has to go through some process of minimal level of evaluation and also the minimum attendance requirement, as stipulated by the Course Instructor and approved by the corresponding BOS, for getting the 'U' grade awarded in a course, failing which that course will not be listed in the Grade Card.
- A 'W' grade is awarded when the student withdraws from the course. Withdrawal from a course is permitted only under extremely exceptional circumstances (like medical emergencies, family tragedies and/or other unavoidable contingencies) and has to be recommended by the HOD and approved by the DAA. However, no withdrawal is permitted after the finalization of the grades in the term.
- 'S'/N' These grades are awarded for the Mandatory Learning Courses. The 'S' grade denotes satisfactory performance and completion of a course. The 'N' grade is awarded for non-completion of course requirements and the student will have to register for the course until he obtains the 'S' grade.

FEEDBACK TO STUDENTS

- A student requires feedback on the progress of his learning. For this purpose, the Instructor will conduct at least two quizzes for a theory

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course in a term-one before Mid-term Examination and the other there after. The quizzes will form a component of class work, the other components being tutorials, home assignments or any other mode.

- For a laboratory course, the continuous assessment's feed back will be given through the laboratory records which are required to be submitted after performing the experiment in the next laboratory class.

EVALUATION

- The double-letter grade awarded to a student in a course other than a practical course i.e. 0-0-P course for which he has registered, shall be based on his performance in quizzes, tutorials, assignments etc., as applicable, in addition to one mid-term examination and end-term examination. The weightage of these components of continuous evaluation may be as follows:

End-term Examination	: 50%
Mid-term Examinations	: 30%
Quizzes, Tutorials, Assignments, etc. (Several over the term)	: 20%
Total	: 100%
- The double letter grade awarded to the student in a practical course i.e. 0-0-P course will be based on his performance in regular conduct of experiments, viva voce, laboratory report, quizzes etc., in addition, to term practical examination. The weightage of the components of continuous evaluation may be as follows:

Conduct of Experiments (as per syllabus)	: 40%
Lab Record	: 10%
Quizzes/Viva Voice	: 20%
End-term Examination	: 30%
Total	: 100%
- The University shall conduct the End-term examination for all theory courses being taught in the term.
- The answer books of all Mid-term Examination and End-term Examination will be shown to the students within three days of the last paper. It is the responsibility of the student to check this evaluation and affix his signature in confirmation.
- If the student finds some discrepancy, he should bring it to the notice of the Course Coordinator. The Course Coordinator will look into the complaint and remove the doubts of the student and proceed with the work of grading.
- If a student is not satisfied with the award of the grade after the announcement of the grades, he may appeal on a Grievance Form duly filled in along with the fee receipt for this purpose to the HOD of the parent department within one week of the following term. The HOD will forward the form along with his recommendation based on the records of the case to DAAB within the date specified in the Academic Calendar.

SCHEME OF EXAMINATION

- The duration of examinations for a theory course will be 3 hours for end-term examination 1½ hours for mid-term examination.
- The pattern of question paper/examination will be as under:
- **Theory Courses:**
The University shall conduct the End-term examination for all theory courses being taught in the term.
 - (a) There will be eight questions in all distributed over all the units in a course syllabus. The question paper will be in three parts with weightage 20 percent, 40 percent and 40 percent respectively.
 - (b) Part-A will be short answer type with multiple parts covering all the units in the syllabus, which will be compulsory.
 - (c) Part-B will have three questions from any three units, which will have long answers of derivation/descriptive type. Two questions are to be answered from this part.
 - (d) Part-C will consist of four questions from the remaining four units and they will be of problem solving type in order to measure ability on comprehension /analysis /synthesis / application. The relevant data will be made available. The student is required to solve two questions. However, for Part-C, the external examiner may select the questions from the question bank supplied by LU.
- Students are allowed in the examination the use of single memory, non-programmable calculator. However, sharing of calculator is not permitted.
- **Laboratory Courses:**
 - (a) The End-term Examination in laboratory course will be conducted jointly by an external examiner (other than the instructor) and an internal examiner (the coordinator / instructor) jointly.
 - (b) The student will be given randomly an experiment to perform from within the list of experiments in the course.
 - (c) No change in the experiment will be permitted after the draw, if the student had performed the same in the class.
- **Mid-Term Examination:**
Question 1 is compulsory covering all topics taught till then. Question 2 and 3 will be essay type, out of which student will answer any one. Question 4 and 5 will be to measure to ability of analysis/comprehension/synthesis/application. The student will answer any one.

TRANSPARENCY

- The answer books of all Mid-term Examination and End-term Examination will be shown to the students within three days of the last paper. It is the responsibility of the student to check this evaluation and affix his signature in confirmation.
- If the student finds some discrepancy, he should bring it to the notice of the Course Coordinator. The Course Coordinator will look into the

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complaint and remove the doubts of the student and proceed with the work of grading.

- The entire process of evaluation shall be transparent, and the course instructor shall explain to a student the marks he is awarded in various components of evaluation.

RESULT

- The final marks shall be displayed on the notice board for ONE day, (the date of which will be indicated in the academic calendar). A student can approach the concerned course instructor(s) for any clarification within Two days of display. The process of evaluation shall be transparent and the students shall be made aware of all the factors included in the evaluation. In case of any correction, the course instructor shall have to incorporate the same before finalization of the grades.
- The Student's Grade Card shall contain the Letter-Grade for each registered course; along with the TGPA at the end of the term, and the CGPA at the completion of the programme.

APPEAL FOR REVIEW OF GRADE

- The entire process of evaluation shall be transparent, and the course instructor shall explain to a student the marks he is awarded in various components of evaluation.
- In case of any grievance about the grades, the student may appeal for review of grades to the Departmental Academic Appeals Board (DAAB) before the date specified in Academic Calendar.
- The fee for such an appeal will be decided from time to time. If the appeal is upheld by DAAB, then the fee amount will be refunded to the student without interest.
- VC shall have power to quash the result of a candidate after it has been declared, if
 - (a) he is disqualified for using malpractice in the examination;
 - (b) a mistake is found in his result;
 - (c) he is found ineligible to appear in the examination

AWARD OF DIVISIONS

- The overall performance of a student will be indicated by two indices:
 - (i) **TGPA** which is the Term Grade Point Average
 - (ii) **CGPA** which is the Cumulative Grade Point Average

TGPA for a Term is computed as follows:

$$TGPA = \frac{\sum C_i G_i}{\sum C_i}$$

Where,

C_i denotes credits assigned to i^{th} course with double-letter grade, and G_i denotes the grade point equivalent to the letter grade obtained by the student in i^{th} course with double-letter grade, including all 'FF' grades in

that term.

CGPA is computed as follows:

$$CGPA = \frac{\sum C_i G_i}{\sum C_i}$$

Where,

C_i denotes credits assigned to i^{th} course with double-letter grade, and G_i denotes the grade point equivalent to the letter grade obtained by the student in i^{th} course for all courses with double-letter grades, including all 'FF' grades in all terms at the end of the programme.

For CGPA calculation, the following grades are to be counted:

- (i) Grades in all core courses,
 - (ii) The best grades in the remaining eligible courses to fulfill the minimum credits requirement for a programme.
- The degree will be awarded only upon compliance of all the laid down requirements for programme as under:
 - (i) There shall be University requirement of earning a minimum credits for a degree, satisfactory completion of mandatory learning courses and other activities as per the course structure.
 - (ii) There shall be a minimum earned credit requirement on all Departmental core courses, Elective course and Major Project as specified by BOS.
 - (iii) There shall be a maximum duration for complying to the degree requirement.
 - (iv) The candidate will be placed in First Division with Honours / First Division with Distinction/First Division/Second Division which will be mentioned on the degree certificate as under:

DIVISION	CONDITIONS TO BE FULFILLED
First Division with Honours	CGPA \geq 8.5 No 'FF', N or W grade in any course during the programme
First Division with Distinction	CGPA \geq 8.5
First Division	CGPA \geq 6.75
Second Division	CGPA \geq 5.0 but $<$ 6.75

Note: Although, there is no direct conversion from grades to marks, however, for comparison purposes percentage of marks may be assumed to be CGPA multiplied by nine.

M. TECH. DEGREE REQUIREMENTS

- The requirements for the M.Tech. degree programme are as follows:
 - (a) **University Requirements:**
 - (i) Minimum Earned Credit Requirement for Degree which is 90.
 - (ii) Securing a CGPA of at least 5.5.
 - (iii) Satisfactory completion of Teaching Practice and Seminars.

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(b) **Programme Requirements:**

Minimum Earned Credit Requirements on all compulsory courses, Core Courses, Elective Courses and dissertation as specified by the BOS and conforming to Course Structure given above.

- (c) The Maximum duration for a student for complying to the degree requirement from the date of registration for his first Term, is FOUR years for full-time registration and FIVE years for part-time registration.

GRADE IMPROVEMENT

- A student may be allowed to improve CGPA in an appropriate term if his CGPA falls below 5.5.

TERMINATION FROM THE PROGRAMME

- A student shall be required to leave the University without the award of the Degree, under the following circumstances:
 - (a) If a student fails to earn the minimum credits specified below:

(i) Full-time student

CHECK POINT	CREDIT THRESHOLD *
End of FIRST year	20

(ii) Part-time student

CHECK POINT	CREDIT THRESHOLD *
End of FIRST year	15
End of SECOND year	30

* If at any stage, a student fails to cross the threshold with a minimum CGPA of 5.5, he will be treated as a critical case and will be advised to improve the grades.

Note: The period of temporary withdrawal is not to be counted for the above Credit Threshold.

- (b) If a student is absent for more than 4 (Four) weeks in a term without sanctioned leave.
- (c) Based on disciplinary action to that effect approved by the AC, on the recommendation of the appropriate committee.
- Under any circumstances of termination, the conditions specified in Permanent Withdrawal shall also apply.

WITHDRAWAL FROM PROGRAMME

Temporary:

- A student who has been admitted to a degree programme of the University may be permitted to withdraw temporarily, for a period of one term or more, on the grounds of prolonged illness or grave calamity in

the family, etc., provided:

- (i) He applies to the University stating fully the reasons for withdrawal together with supporting documents and endorsement from his parent/guardian
 - (ii) There are no outstanding dues or demands, from the Departments / University / Hostels / Library and any other centers;
 - (iii) Scholarship holders are bound by the appropriate Rules applicable to them.
 - (iv) The decision of the VC of the University regarding withdrawal of a student is final and binding.
- Normally, a student will be permitted only one such temporary withdrawal during his tenure as a student and this withdrawal will not be counted for computing the duration of study.

Permanent:

- Any student who withdraws permanently admission before the closing date of admission for the Academic Session is eligible for the refund of fee as per the University rules. Once the admission for the year is closed, the following conditions govern withdrawal of admission:
- A student who wants to leave the University for good, will be permitted to do so (and take Transfer Certificate from the University, if needed), only after clearing all the dues for the remaining duration of the course.
- A student who has received any scholarship, stipend or other form of assistance from the University shall repay all such amounts, in addition, to those mentioned in clause no. G8.2 (a) above.
- The decision of the VC regarding all aspects of withdrawal of a student shall be final and binding.

Department of Mechanical Engineering M.Tech. Degree Programme

DEGREE OBJECTIVE

The student is provided with an opportunity to:

1. Acquire deeper knowledge and analytical abilities through advanced treatment of subjects
2. Develop application skills through practice, computer methods, use of softwares, etc
3. Develop presentation skills through seminars
4. Apply knowledge gained in the thesis work through challenging problems

The three year Part Time M Tech Mechanical Engineering course structure has first year common for all. The common courses in the first year include basic subjects like, Numerical Techniques, Advanced Mechanics of Solids, Vibration Engineering, Properties of Materials, Finite Element Analysis and Instrumentation and Automatic Control.

From second year onwards, the students are allowed to exercise option to specialize in

- a) Design of Mechanical Equipment, and
- b) Production Engineering depending upon their aptitude.

SCHEME OF STUDIES

M.Tech. Mechanical Engineering (Full Time)

1st Year

TERM-I				
Sr. No.	Course No.	Course Name	L-T-P	Cr
1	MA-501	Numerical Techniques	5-1*0	4
2	ME-501	Advanced Mechanics of Solids	5-1*0	4
3	ME-502/ ME 503	Computer Methods in Mechanical Design/ Metal Cutting Technology	5-1*0	4
4	ME-555	Simulation Lab	0-0-4	2
5	ME-556/ ME 557	Mechanical Engineering Lab-I/ Mechanical Engineering Lab-I	0-0-4	2
15-3*-8 (26)				16

TERM-II

Sr. No.	Course No.	Course Name	L-T-P	Cr
1	ME-509	Vibration Engineering	5-1*0	4
2	ME-510	Instrumentation and Automatic Control	5-1*0	4
3	ME-511/ ME 512	Optimum Design of Mechanical System/ Mechanics of Metal Forming	5-1*0	4
4		Elective-I Streat-I/ Elective-I Streat-II	5-0-0	3
5	ME 570	Mechanical Engineering Lab-II	0-0-4	2
20-3*-4 (27)				17

TERM-III

Sr. No.	Course No.	Course Name	L-T-P	Cr
1	ME-521	Finite Element Methods	5-1*0	4
2	ME-522	Properties and Selection of Engineering Materials	5-1*0	4
3		Elective-II Stream-I/ Elective-II Stream-II	5-0-0	3
4	ME-579	Mechanical Engineering Lab-III	0-0-4	2
5	ME-580	Seminar-I	0-0-2	1
15-2*-6 (23)				14

SCHEME OF STUDIES

M.Tech. Mechanical Engineering (Full Time)

2nd Year

TERM-IV				
Sr. No.	Course No.	Course Name	L-T-P	Cr
1	ME-601/ ME-602	Mechatronics Product Design/ CAD/CAM For Manufacturing	5-1*0	4
2	ME-604/ ME-605	Design of Mechanisms & Manipulators / Design, Planning and Control of Production System	5-1*0	4
3	ME-657/ ME-658	Mechanical Engineering Lab-IV/ Mechanical Engineering Lab-IV	0-0-4	2
4	ME-660	Dissertation Preliminary**	0-0-10	(5)
5	ME-661	Seminar-II	0-0-4	2
10-2*-18 (30)				17

TERM-V

Sr. No.	Course No.	Course Name	L-T-P	Cr
1	ME-612/ ME-613	Advanced Mechanical Design/ Automation in Manufacturing	5-1*0	4
2	ME-665	Dissertation Phase-I**	0-0-12	(6)
3	ME-666	Minor Project	0-0-6	3
4	ME-667	Seminar-III	0-0-4	2
20-3*-4 (27)				17

TERM-VI

Sr. No.	Course No.	Course Name	L-T-P	Cr
1	ME-668	Dissertation Phase-II	0-0-24	12+5+6
2	ME-669	Teaching Practice-I****		(2)
3	ME-670	Teaching Practice-II		2+2
0-0-24 (24)				27

LIST OF ELECTIVES

Stream-I (Design)

Elective – I				
S.N.	Course No.	Course Name	L-T-P	Cr.
1	ME-514	Industrial Tribology	5-0-0	3
2	ME-515	Industrial Robotics	5-0-0	3
Elective – II				
S.N.	Course No.	Course Name	L-T-P	Cr.
1	ME-523	Machine Tool Design	5-0-0	3
2	ME-524	Product Design	5-0-0	3

Stream-II (Production)

Elective – I				
S.N.	Course No.	Course Name	L-T-P	Cr.
1	ME-516	Statistical Quality Control	5-0-0	3
2	ME-517	Artificial Intelligence in Manufacturing	5-0-0	3
Elective – II				
S.N.	Course No.	Course Name	L-T-P	Cr.
1	ME-525	Welding and Allied Processes	5-0-0	3
2	ME-526	Foundry Technology	5-0-0	3

(L-T-P-Cr) - Lectures-Tutorials-Practicals-Credits
FINAL EVALUATION IN GRADES

- * Period will be used for self study resulting in submission of Term Paper.
- ** Credits earned (5/6) through evaluation will be added in Term-VI under course Dissertation Phase-II.
- *** Credits earned (2) through evaluation will be added under course ME-670 Teaching Practice-II. It is a mandatory learning course.

Note : The student has an option to choose either Stream-I or Stream-II of the courses which have been shown as alternative in the main scheme and separately in the matrix form.

SUGGESTED PLAN OF STUDIES

M. Tech.-Mechanical Engineering (Full Time)

Stream-I (DESIGN)

Course→	1	2	3	4	5
Term-I	MA-501	ME-501	ME-502	ME-555	ME-556
Term-II	ME-509	ME-510	ME-511	Elective-I Stream-I	ME-570
Term-III	ME-521	ME-522	Elective-II Stream-I	ME-579	ME-580
Term-IV	ME-601	ME-604	ME-657	ME-660	ME-661
Term-V	ME-612	ME-665	ME-666	ME-667	-
Term-VI	ME-668	ME-669	ME-670	-	-

Stream-II (PRODUCTION)

Course→	1	2	3	4	5
Term-I	MA-501	ME-501	ME-503	ME-555	ME-557
Term-II	ME-509	ME-510	ME-512	Elective-I Stream-II	ME-570
Term-III	ME-521	ME-522	Elective-II Stream-II	ME-579	ME-580
Term-IV	ME-602	ME-605	ME-658	ME-660	ME-661
Term-V	ME-613	ME-665	ME-666	ME-667	-
Term-VI	ME-668	ME-669	ME-670	-	-

SCHEME OF STUDIES
M.Tech. Mechanical Engineering (Part Time)

1st Year

TERM-I				
Sr. No.	Course No.	Course Name	L- T-P	Cr
1	MA-501	Numerical Techniques	5-1*-0	4
2	ME-501	Advanced Mechanics of Solids	5-1*-0	4
3	ME-555	Simulation Lab	0-0-4	2
10-2*-4 (16)				10

TERM-II				
Sr. No.	Course No.	Course Name	L- T-P	Cr
1	ME-509	Vibration Engineering	5-1*-0	4
2	ME-510	Instrumentation and Automatic Control	5-1*-0	4
3	ME 570	Mechanical Engineering Lab-II	0-0-4	2
10-2*-4 (16)				10

TERM-III				
Sr. No.	Course No.	Course Name	L- T-P	Cr
1	ME-521	Finite Element Methods	5-1*-0	4
2	ME-522	Properties and Selection of Engineering Materials	5-1*-0	4
3	ME-579	Mechanical Engineering Lab-III	0-0-4	2
10-2*-4 (16)				10

SCHEME OF STUDIES
M.Tech. Mechanical Engineering (Part Time)

2nd Year

TERM-IV				
Sr. No.	Course No.	Course Name	L- T-P	Cr
1	ME-502/ ME 503	Computer Methods in Mechanical Design / Metal Cutting Technology	5-1*-0	4
2	ME-604/ ME-605	Design of Mechanisms and Manipulators / Design, Planning and Control of Production System	5-1*-0	4
3	ME-556/ ME-557	Mechanical Engineering Lab-I/ Mechanical Engineering Lab-I/	0-0-4	2
10-2*-4 (16)				10

TERM-V				
Sr. No.	Course No.	Course Name	L- T-P	Cr
1	ME-601/ ME-602	Mechatronics Product Design/ CAD/CAM For Manufacturing	5-1*-0	4
2		Elective-I Stream-I/ Elective-I Stream-II	5-0-0	3
3	ME-657/ ME-658	Mechanical Engineering Lab-IV/ Mechanical Engineering Lab-IV	0-0-4	2
10-1*-4 (15)				9

TERM-VI				
Sr. No.	Course No.	Course Name	L- T-P	Cr
1		Elective-II Stream-I/ Elective-II Stream-II	5-0-0	4
2	ME-666	Minor Project	0-0-6	3
3	ME-580	Seminar-I	0-0-2	1
5-0-8 (13)				8

SCHEME OF STUDIES

M.Tech. Mechanical Engineering (Part Time)

3rd Year

TERM-VII				
Sr. No.	Course No.	Course Name	L- T-P	Cr
1	ME-511/ ME-512	Optimum Design of Mechanical System/ Mechanics of Metal Forming	5-1*-0	4
2	ME-660	Dissertation Preliminary **	0-0-10	(5)
3	ME-661	Seminar II	0-0-4	2
5-1*-4 (11)				6

TERM-VIII				
Sr. No.	Course No.	Course Name	L- T-P	Cr
1	ME-612/ ME-613	Advanced Mechanical Design/ Automation in Manufacturing	5-1*-0	4
2	ME-665	Dissertation Phase-I**	0-0-12	(6)
3	ME-669	Teaching Practice-I***		2
5-1*-0 (6)				6

TERM-IX				
Sr. No.	Course No.	Course Name	L- T-P	Cr
1	ME-667	Seminar III	0-0-4	0
2	ME-668	Dissertation Phase-II	0-0-24	12+5+6
3	ME-670	Teaching Practice II ***		(2)
0-0-28 (28)				23

LIST OF ELECTIVES

Stream-I (Design)

Elective – I				
S.N.	Course No.	Course Name	L-T-P	Cr.
1	ME-514	Industrial Tribology	5-0-0	3
2	ME-515	Industrial Robotics	5-0-0	3
Elective – II				
S.N.	Course No.	Course Name	L-T-P	Cr.
1	ME-523	Machine Tool Design	5-0-0	3
2	ME-524	Product Design	5-0-0	3

Stream-II (Production)

Elective – I				
S.N.	Course No.	Course Name	L-T-P	Cr.
1	ME-516	Statistical Quality Control	5-0-0	3
2	ME-517	Artificial Intelligence in Manufacturing	5-0-0	3
Elective – II				
S.N.	Course No.	Course Name	L-T-P	Cr.
1	ME-525	Welding and Allied Processes	5-0-0	3
2	ME-526	Foundry Technology	5-0-0	3

(L-T-P-Cr) - Lectures-Tutorials-Practicals-Credits
FINAL EVALUATION IN GRADES

- * Period will be used for self study resulting in submission of Term Paper.
- ** Credits earned (5/6) through evaluation will be added in Term-VI under course Dissertation Phase-II.
- *** Credits earned (2) through evaluation will be added under course ME-670 Teaching Practice-II. It is a mandatory learning course.

Note : The student has an option to choose either Stream-I or Stream-II of the courses which have been shown as alternative in the main scheme and separately in the matrix form.

SUGGESTED PLAN OF STUDIES M. Tech.-Mechanical Engineering (Part Time)

IMPORTANT NOTES

Stream-I (DESIGN)

Course→	1	2	3
Term-I	MA-501	ME-501	ME-555
Term-II	ME-509	ME-510	ME 570
Term-III	ME-521	ME-522	ME-579
Term-IV	ME-502	ME-604	ME-556
Term-V	ME-601	Elective-I Stream-I	ME-657
Term-VI	Elective-II Stream-I	ME-666	ME-580
Term-VII	ME-511	ME-660	ME-661
Term-VIII	ME-612	ME-665	ME-669
Term-IX	ME-667	ME-668	ME-670

1. Laboratory Courses are being offered as distinct courses without being mixed with lecture components.
2. Conduct of Lab Courses:
 - a. It is expected that more experiments/programs/exercises are designed and set as per the scope of the syllabus, which may be added to the above list.
 - b. One or more than one experiments/programs/exercises may be performed in one lab period in order to utilize the time properly.
 - c. The scheme of operation is to be approved by HOD.
3. Students are allowed in the examination the use of single memory, non-programmable calculator. However, sharing of calculator is not permitted.

Stream-II (PRODUCTION)

Course→	1	2	3
Term-I	MA-501	ME-501	ME-555
Term-II	ME-509	ME-510	ME 570
Term-III	ME-521	ME-522	ME-579
Term-IV	ME 503	ME-605	ME-557
Term-V	ME-602	Elective-I Stream-II	ME-658
Term-VI	Elective-II Stream-II	ME-666	ME-580
Term-VII	ME-512	ME-660	ME-661
Term-VIII	ME-613	ME-665	ME-669
Term-IX	ME-667	ME-668	ME-670

DETAILED SYLLABUS

MA-501	NUMERICAL TECHNIQUES	L-T-P	Cr
		5-1*-0	4

OBJECTIVE

To develop expertise on mathematical numerical tools to get analytic solutions for complex engineering problems.

- 1. LINEAR EQUATIONS-** Matrix theory; solution of general linear system of equations, existence and uniqueness of solution, Echelon form of matrix; I, II conditioned matrices Eigen value and Eigen vectors; Unitary, Hermitian and normal matrices; Gauss-elimination method and Gauss-Jordan methods for homogeneous and non-homogeneous systems of linear equations; round off errors
- 2. NON-LINEAR EQUATIONS:** Bisection method; linear interpolation methods; Newton's method; Muller's method; Bairstow's methods for the quadratic factors; other methods for the solution of polynomials.
- 3. INTERPOLATION PROBLEMS:** Lagrangian polynomial; divided differences; interpolating with cubic spline; Bexier curves and B-spline curves; polynomial approximation of the surfaces; least square method.
- 4. DIFFERENTIATION AND INTEGRATION:** Derivatives from difference table; higher order derivatives; extrapolation techniques; integration formulas- Simpson's rule, trapezoidal rule, Gaussian quadrature; adaptive integration, multiple integrals.
- 5. SOLUTION OF ORDINARY DIFFERENTIAL EQUATION:** Modifier Euler methods; Milne's methods Adam's Moulton method; convergence criteria, Errors and error propagation, comparison of different methods.
- 6. BOUNDARY VALUE PROBLEMS:** Shooting method; Rayleigh-Ritz method; Collocation and Galerkin method; characteristic value problem, eigen values by iteration and QR method; application of Eigen values.
- 7. SOLUTION OF PARTIAL DIFFERENTIAL EQUATION:** Laplace's equations on a rectangular region; iterative method for the Laplace equation; Poisson equation; A.D.I method; solution of parabolic differential equation by Crank – Nicholson method; theta method; solution of wave equation by Finite differences; wave equation in two dimensions.

REFERENCE BOOKS

1. Kreyszig, Erwin, "Advanced Engineering Mathematics", John Wiley, 1999.
2. Greenberg, Mchale. D "Advanced Engineering Mathematics" Second Edition, Pearson Education, 1998.
3. Jain, R.K. and Iyengar, S.R.K., "Advanced Engineering Mathematics", Narosa 2002.
4. Gerald, Curtis F and Wheatley, Patrick O, "Applied Numerical Analysis", 5th Ed., Wesley, 1998.

5. Jain, M.K., Iyengar, S.R.K. and Jain, R.K. "Numerical Methods for scientific and Engineering Computation", New Age, 1993

ME-501	ADVANCED MECHANICS OF SOLIDS	L-T-P	Cr
		5-1*-0	4

OBJECTIVE

This course will provide a firm foundation to the students in mechanics of deformable solids to enable them to analyse and solve a variety of strength related design problems encountered in practice.

- 1 ANALYSIS OF STRESS AND STRAIN:** Definition; Notation; Symmetry of the stress array and stress on an arbitrarily oriented plane; Transformation of stress, principal stresses and other properties; Differential equation of motion of a deformable body; Deformation of a deformable body; Strain theory, transformation of strain and principal strains; Small displacement theory; strain measurement and strain rosettes.
- 2 LINEAR STRESS-STRAIN-TEMPERATURE RELATIONS & INELASTIC MATERIAL BEHAVIOR:** Generalized Hooke's law; stress-strain relations; strain energy density of isotropic elastic materials; equations of thermo elasticity for isotropic materials. Inelastic Material Behavior: Limitations on the use of uniaxial stress-strain data; Nonlinear material response; yield criteria; various theories of failure; comparison and interpretation.
- 3 ENERGY METHODS:** Principle of stationary potential energy; Castigliano's theorem on deflections for Linear Load-Deflection relations; Deflections of statically determinate and indeterminate structures.
- 4 TORSION:** Torsion of a prismatic bar of circular cross section; Saint-venants' semi inverse method; Linear elastic solution, elliptical cross section, equilateral triangle cross section; The Prandtl Elastic-Membrane (Soap-Film Analogy); Narrow rectangular cross section; Hollow thin-wall torsion members and multiply connected cross sections.
- 5 BENDING OF STRAIGHT AND CURVED BEAMS.** Symmetrical bending; Unsymmetrical bending; shear centre for thin-wall beam cross sections; circumferential stresses in a curved beam; Deflections of curved beams; stresses in a closed ring and chain link.
- 6 AXISYMMETRIC PROBLEMS:** Thick-walled cylinder and sphere subjected to internal and external pressure; composite tubes; auto fretage Rotating discs, uniform thickness, variable thickness; rotating shafts and cylinders
- 7 FLAT PLATES:** Stress resultants in a flat plate; strain-displacement relations, Rotation of a plate surface element; Equilibrium equations for small displacement theory; Stress strain relations for isotropic plates; Boundary conditions for plates; Solution of rectangular plate and circular plate problems.

REFERENCE BOOKS:

1. Boresi, Arthur, P & Schmidt, Richard J., "Advanced Mechanics of Materials", Wiley, Asia.
2. Srinath, L.S, "Advanced Mechanics of Solids", Tata McGraw Hill
3. Raju, N, Krishan and Gururaje, "Advanced Mechanics of Solids and Structures", Narosa.

ME-502	COMPUTER METHODS IN MECHANICAL DESIGN	L-T-P	Cr
		5-1*-0	4

OBJECTIVE

To develop expertise in computer applications for design and engineering

1. **INTRODUCTION AND OVERVIEW:** Need and scope of computer aided machine design; role of geometric modeling; FE and optimization; principles of interactive computer graphics; overview of hardware available for use in CAD.
2. **GEOMETRIC TRANSFORMATIONS AND PROJECTIONS:** Windowing and view-portioning.
3. **GEOMETRIC MODELING:** Modeling of curves, cubic, splines, beziers and b-splines; Modeling of surfaces.
4. **MODELING OF SOLIDS:** b-rep, CSG, Octree, feature based modeling.
5. **INTRODUCTION TO FINITE ELEMENT METHOD:** Principle of potential energy; 1 D elements; derivation of stiffness and mass matrices for a bar, a beam and shaft; comparison with analytical results.
6. **SOLUTION OF STATIC PROBLEMS:** Case studies in stress analysis of mechanical components; FEA using 2D and 3D elements; plain strain and plain stress problems; FE using plates / shell elements.
7. **IMPORTANCE OF FINITE ELEMENT MESH:** Automatic meshing techniques', interfaces with CAD software; case studies using FEM for design of simple element geometries such as tapered bar; a plate with a hole and a spanner; introduction to dynamic analysis; limitations of FEM.

REFERENCE BOOKS

1. Rogers, David F and Adams, J. Alan, "Mathematical Elements for Computer Graphics", Tata McGraw-Hill, 2000.
2. Radhakrishnan and Kothandaraman, "Computer Graphics and Design", Dhanpat Rai, 1997.
3. Bath, Klaus, Jungen, "Finite Element Procedures." Prentice Hall of India, 1997.
4. Patla, Chandru, Tirupathi, R and Belegundu, Ashok D, "Introduction to Finite Elements in Engineering" Prentice Hall of India, 2000.
5. Rogers, David F, "Procedures Elements for Computer Graphics", Second Ed McGraw Hill, 2001.
6. Reddy, "An Introduction to the Finite Method", Second Ed., McGraw Hill
7. Zienkiewicz, "The Finite Element Method", Third Ed., McGraw Hill.
8. Rao, SS., "The Finite Element Method Engineering", Third Ed., Butterworth-Heinemann, 1999.

M.Tech. (ME)

9. Dukhipati, R.V., Rao, Ananda and Bhat, E, "Computer Aided Analysis and Design of Machine Elements", New Age, 2004.

ME- 503	METAL CUTTING TECHNOLOGY	L T P	Cr
		5 1* 0	4

OBJECTIVE

The students are provided with an opportunity to acquire deeper knowledge of metal cutting as regards to tool geometry, cutting forces, design of tools for different operations on all types of machines - conventional and non conventional

1. **TOOL GEOMETRY, TOOL and WORK PIECE MATERIAL:** Common work and Tool material; Nomenclature system; cutting friction; controlled contact machining.
2. **PHYSICAL PRINCIPLE IN METAL CUTTING:** Chip formation and types of chips; work done in cutting; BUE on metal cutting; curling and contraction of chip ; work hardening; quality of machine surfaces; Effect of cutting fluid on cutting process; vibration in metal cutting.Machining economics; cutting power; Tool wear; lubrication and surface finish; cutting fluids.
3. **TURNING, BORING AND THREADING TOOLS:** Operation; signature of single point tools; Design of single point turning tool; ISO tool shaper; design of flat and circular form tools; Boring tools; threading tools chip breaking methods.
4. **MILLING, BROACHING, GEAR CUTTING TOOLS:** Milling cutter design; design of broach; design of Gear hobs.
5. **TOOLS FOR HOLES:** Hole starters; Reaming; Design of Drills; Reamer.
6. **GRINDING:** Features of grinding process; characteristics; shapes; mounting; wear; turning; Dress of Abrasive tools; center type cylindrical grinding; centreless grinding; internal grinding; surface grinding; grinding fluid
7. **MODERN MACHINING PROCESSES:** USM; Abrasive Jet Machining; water jet machining; electrochemical machining; grinding; deburring; Honing; EDM; plasma arc machining; Laser Beam machining; Electro Beam machining Process detail; Metalcutting mechanics; applications.

REFERENCE BOOKS:

1. Arshinov, V, G. Allekseev, "Metal Cutting Theory and Cutting Tool Design", Mir Publishers.
2. Joshi P.H., "Cutting Tools", Wheeler Publishing
3. Trent, E.M, "Metal cutting".
4. Cyril, "Tool Design: Donaldson", Tata McGraw Hill, 1st Ed. 2001
5. HMT, "Production Technology", Tata McGraw Hill, New Delhi
6. Pandey, P.C, Shah H.S, "Modern Machining Processes", Tata McGraw Hill

ME-509	VIBRATION ENGINEERING	L-T-P	Cr
		5-1*-0	4

OBJECTIVE

To develop knowledge of vibration management, i.e. to understand basics of vibration and control vibration within limits. It also provides exposure to dynamics of vibration, validation of vibration measurement techniques and mathematical modeling of vibration signatures.

- 1 INTRODUCTION:** Unwanted mechanical vibrations and their harmful effects including those on human beings; Experimental and theoretical routes to vibration engineering; vibration testing.
- 2 SPATIAL MODAL AND RESPONSE MODELS OF VIBRATING SYSTEMS:** Lumped parameter and distributed parameter modeling of mechanical vibratory systems; free vibrations and forced response solutions of single degree-of-freedom models including modeling of damping.
- 3 FREE AND FORCED VIBRATION** of multi degree of freedom system with and without damping.
- 4 APPLICATIONS OF NUMERICAL PROCEDURES:** Determining natural frequencies and mode shapes; Finite Element Method for dynamic analysis; distributed parameter model of rods, bars and beams.
- 5 VIBRATION CONTROL SOLUTIONS:** Balancing of rotating and reciprocating machines; design of vibration isolators; auxiliary mass systems including tuned dampers for vibration control; application of damping treatment for vibration control in machines and structures; dynamic instability control.
- 6 INTRODUCTION TO MODAL TESTING:** Model updating and structural dynamic modification to improve dynamic design of machine structures.
- 7 VIBRATION CONTROL:** strategies and case studies.

REFERENCE BOOKS

1. Rao, S.S., "Mechanical Vibration", IV Edition, Pearson, 2004.
2. Meirowitch, L., "Elements of Vibration Analysis", Mc Graw Hill, 1974.
3. Malik, Ashok Kumar, "Principles of vibration control", Affiliated EWP, 1990
4. Thomson, W T, "Theory of Vibration with Applications", CBS, 2002
5. Murthy, Rama, "Mechanical Vibration Practice with Basics", Narosa, 2001.
6. Dukupati, R.V., "Vibration Analysis", Narosa, 2002.
7. Rao, J.S., "Advanced Theory of Vibrations", John Wiley, 1992.
8. Harris, Cyril M, "Harris' Shock and Vibration Handbook", 5th Ed., McGraw Hill.

ME-510	INSTRUMENTATION AND AUTOMATIC CONTROL	L-T-P	Cr
		5-1*-0	4

OBJECTIVE

To develop expertise and knowledge of sophisticated instruments, functioning, measurement techniques and control philosophy in general as well related to instruments. The course also covers state of the art practices/ technologies related to instrumentation / control.

- 1 CLASSIFICATION AND REPRESENTATION OF CONTROL SYSTEMS:** Influence of type of control on steady state and transient response; time and frequency domain analysis; stability analysis using Routh and Nyquist criteria; Root locus method.
- 2 MODEM CONTROL THEORY:** Sequence control and programmable logic controllers.
- 3 CONTROL COMPONENTS:** Comparators; hydraulic, pneumatic and electrical types of controllers; servomotors; electromechanical and electro-optical transducers and control elements.
- 4 SIGNAL PROCESSING:** Signal conditioning & indicating/recording elements.
- 5 COMPUTER BASED DATA ACQUISITION SYSTEMS:** A-D and D-A converters; Microprocessor applications in measurement and control.
- 6 STATIC AND DYNAMIC ANALYSIS OF INSTRUMENT SYSTEMS:** signal and systems analysis; FFT analysers.
- 7 CURRENT DEVELOPMENTS:** Measurement and control of motion; force, torque pressure; temperature, flow, noise etc.; virtual instrumentation; laser based instrumentation.

REFERENCE BOOK:

1. Doebllin, Ernest O, "Measurement Systems Application and Design", Tata Mc Graw Hill, 1990.
2. Raven, Francis N, "Automatic Control Engineering", Fifth Ed., Mc Graw Hill, 1995.
3. Yuu, Benjamin C and Gelnarghi, Farid, "Automatic Control System", 8th Edition, John Wiley, 2003.
4. Dorf, Richard, C, and Bishop, Robert H, "Modern Control System", Addison Wesley, 1998.
5. Filiola, "Theory and Design for Mechanical Measurements", Third Ed., John Wiley
6. Bechwith, TG, Marangono, RD and Lienhard, VJH, "Mechanical Measurements", Fifth Ed. 2nd Indian reprint, Addison Wesley, 2000.

ME-511	OPTIMUM DESIGN OF MECHANICAL SYSTEMS	L-T-P	Cr
		5-1*-0	4

OBJECTIVE

This course will enable students to design systems which are safer, more efficient, more comfortable and more economical.

- 1. INTRODUCTION:** Optimum design of mechanical systems; need of optimization of preliminary design by identification of design requirements and by use of appropriate design strategy.
- 2. DETAIL DESIGN:** Optimization by simulation; prototyping and optimum selection of configuration; materials and processes.
- 3. SYSTEM DESIGN:** Mechanical system design problems economic political environment; issues of human safety and welfare and professional ethics.
- 4. DESIGN CONCEPTS:** Optimum mechanical design concepts; overview and application of optimization methods to machine elements and mechanical system design.
- 5. OPTIMIZATION METHODS:** Prototyping; simulation and use of standards for detail design optimization; optimum selection of material and processes in mechanical design using material selection charts and optimization methods.
- 6. OPTIMIZING PRODUCT DESIGN:** Functionality; aesthetics and economics by employing industrial design principles and by suitable selection of material and processing including use of polymers; composites and other non metallic materials.
- 7. DEVELOPMENT PROCEDURE:** Development of Optimization procedure and computer programmers for the same.

REFERENCE BOOKS

1. Papalambros, P.Y. and Wilde D.J., "Principles of Optimal Design", Cambridge University, 2000.
2. Ashby, M.F., "Materials selection in Mechanical Design", Butterworth Heinemann, 1999
3. Rao, S.S., "Engineering Optimization-Theory and Practice", New Age, 1996.
4. Arora, J.S., "Introduction to Optimum Design", McGraw Hill, 1989,
5. Dieter, George E., "Engineering Design: A Material and Processing Approach", Third Ed., McGraw Hill, 2000
6. Bralla, J.G., "Handbook of Product Design for Manufacturing", McGraw Hill, 1998
7. Chitale, AK and Gupta, RC, "Product Design and Manufacturing", Second Ed, Prentice Hall, 2002
8. Otto, K and Wood, K, "Product Design Techniques in Reverse Engineering and New Product Development", Pearson, 2001

ME-512	MECHANICS OF METAL FORMING	L-T-P	Cr
		5-1*-0	4

OBJECTIVE

The students are provided with an opportunity to acquire deeper knowledge of metal forming as regards to stress-strain analysis, theory of plasticity, finite elements methods. Some important case studies are also discussed. After the course, the students will be in a position to design the process planning for different jobs.

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- 1 STRESS-STRAIN:** Stress-Strain relations in Elastic and plastic Deformations; Yield Criteria for Ductile Metals; Work hardening and Anisotropy in Yielding; Flow Curves. Formulations of plastic deformation problems
- 2 THEORY OF PLASTICITY:** Application of theory of plasticity for solving metal forming problems using Slab method; Upper and lower Bound methods; Slip line field theory Effects of temperature and strain rate in metal working; friction and lubrication in Hot and Cold working.
- 3 METAL FORMING PROCESSES:** Technology and analysis of important metal forming processes- Forging; Rolling; Extrusion. Wire drawing; Sheet Metal forming processes like Deep drawing; Stretch forming; Bending
- 4 FINITE ELEMENT METHOD:** Application of Finite Element Methods to Metal Forming Processes- special Discretization; Shape function; Stiffness matrices and their assembly; Implicit and explicit formulations; Elasto-plastic approximations;
- 5 LAGRANGIAN and EULARIAN SCHEMES:** Lagrangian Vs Eularian schemes; Material integration schemes; auxiliary equations for contact; friction and incompressibility;
- 6 THERMO-MECHANICAL PROBLEMS:** Thermo-mechanical problem formulation; steady state solutions for Drawing; Forging; rolling and extrusion problems.
- 7 CASE STUDIES:** Analysis and validation of metal forming processes problems by standard softwares. Forming defects in products and their critical effects; remedies; an introduction to use of International standards in Metal Forming Problem solutions and system Design.

REFERENCES BOOKS:

1. Wagoner, R. H, "Metal Forming Analysis", Cambridge University Press, 2005
2. Dally and Riley, "Theory of Elasticity", Springer US, 2007
3. Dieter, "Physical Metallurgy", McGraw Hill Inc.
4. Frontzek, H, "Metal Forming Handbook M Kasparbauer", Springer Verlag

ME-514	INDUSTRIAL TRIBOLOGY	L-T-P	Cr
		5-0-0	3

OBJECTIVE

To impart knowledge on wear, tear and lubrication in mechanical systems. To appraise about functioning of various lubrication techniques and best practices adopted in lubrication to ensure smooth functioning of machines.

- 1 INTRODUCTION:** History of tribology; properties of lubricants-viscosity; effect of temperature and presence on viscosity, measurement of viscosity; generalized Reynolds equation; flow and shear stress; energy equation.

- 2 **LAWS OF FRICTIONS:** Friction theories, friction heating; effect of sliding speed on friction; classification of wear; mechanisms of wear; delamination theory of wear; wear resistance materials.
- 3 **HYDRODYNAMIC BEARINGS:** Mechanism of pressure development, Idealized journal bearing; numerical solution of finite bearings; circumferential and aerial flow; oil flow through a bearing having circumferential oil groove; thermal equilibrium; design of journal bearing.
- 4 **FILM BEARINGS:** Paralled surface and step squeeze film bearings; mechanism of hydrodynamic instability; stiffness and damping coefficient, stability; effect of surface roughness on journal bearing.
- 5 **HYDROSTATIC BEARINGS:** System of hydrostatic lubrication; circular step bearings, rectangular thrust bearings; opposed pad bearing; multirecess journal bearing; hydrostatic lift.
- 6 **ELASTOHYDRODYNAMIC LUBRICATION (EHL):** Hydrodynamic equation; elastic deformation; Grubin type solution, accurate solution; dimensionless parameters; film thickness equation; different regimes in the EHL contact; EHL point contact and line contact.
- 7 **BALL BEARINGS:** Deep groove radial bearing; angular contact bearing; thrust ball bearing; geometry and kinematics; stress and deformation; load capacity; prediction of fatigue life, lubrication.

REFERENCE BOOKS

1. Majumdar, B.C., "Introduction to Tribology of Bearings", A.H. Wheeler, 1986
2. Hamrock, Bernard J, "Fundamentals of Fluid Film Lubrication", McGraw Hill, 1994
3. Cameron, A, "Principles of Lubrication", Longman, 1966
4. Cameron, A., "Basic Lubrication Theory ", Third Ed., Wiley Eastern, 1981

ME-515	INDUSTRIAL ROBOTICS	L-T-P	Cr
		5-0-0	3

OBJECTIVE

To provide expertise and knowledge of Manipulators design, robotics functions, elements, control of robot elements, robot programming and automation techniques.

- 1 **INTRODUCTION:** Spatial descriptions and transformations; positions and Orientations; operators, translations and rotations; transform equations computational considerations.
- 2 **KINEMATICS AND INVERSE KINEMATICS:** Link and connection descriptions; manipulator kinematics; actuator space; joint space and cartesian space; inverse kinematics solvability, solution by reduction to polynomial. Pieper's solution for three intersecting axes; solving a manipulator; repeatability and accuracy; Jacobeans, Velocities and Static Forces: linear and rotational velocities of rigid bodies; motion of the links of a robot; Velocity propagation from link to link; Jacobeans; singularities, Static forces; Jacobean in the force domain.

- 3 **MANIPULATOR DYNAMICS ITERATIVE NEWTON:** Euler dynamic formulation; iterative vs closed form; manipulator dynamic equations, LaGrange formulations of manipulator dynamics; manipulator dynamics in cartesian space; inclusion of coulomb friction; dynamic simulation.
- 4 **TRAJECTORY GENERATION:** Path description and generation; joint space and Cartesian space schemes; problems with Cartesian paths.
- 5 **MANIPULATOR MECHANISM DESIGN:** Basing the design on task requirements; kinematics configuration; work space attributes, redundant and closed chain structures; actuation schemes; stiffness and deflection; position and force sensing.
- 6 **CONTROL OF MANIPULATORS:** Control of second order linear systems; control law partitioning; trajectory following control; continuous and discrete time control; modeling and control of a single joint; non-linear and time varying systems; control problem; practical considerations and present industrial robot control systems; Lyapunov stability analysis; Cartesian based control system; adaptive control; application of industrial robots to assembly tasks; the hybrid position and force control; present industrial robot control schemes.
- 7 **ROBOT PROGRAMMING LANGUAGES AND SYSTEMS:** The three levels of robot programming; requirements of a robot programming language; an example application coded in three RPLs; off-line programming systems.

REFERENCE BOOKS

1. Craig, John, "Introduction to Robotics Mechanics and Control", Second Ed., Pearson, 2004.
2. Yoshikawa, T, "Foundation of Robotics: Analysis and Control", Prentice Hall of India, 1998.
3. Schilling, R.J., "Fundamentals of Robotics: Analysis and Control", Prentice Hall of India, 1990.
4. Klafter, R.D., Chimielewski, T.A. and Negin Michael "Robotics Engineering An Integrated Approach", Prentice Hall of India, 1989.
5. Mittal, R.K. and Nagrath, I.J., "Robotics & Control", Tata McGraw Hill, 2003.
6. Nikku Saeed N. "Introduction to Robotics Analysis Systems, Application", Prentice Hall of India, 2001

ME-516	STATISTICAL QUALITY CONTROL	L-T-P	Cr
		5-0-0	3

OBJECTIVE

The student is provided with an opportunity to acquire deeper knowledge of quality and how to control quality in industry by using inspection; control charts and acceptance sampling techniques.

- 1 **INTRODUCTION:** Statistical concepts in quality control; graphical representation of grouped data; continuous and discrete probability distributions; control limit theorem.

- 2 **CONTROL CHARTS FOR VARIABLES - I:** Introduction to Quality control; process control and Product Control; chance and Assignable causes of Quality variation; Advantages of shewhart control charts; Process control charts for variables; X; and R charts; fixation of control limits; Type I and Type II Errors; Theory of runs; Interpretation of Out of Control points.
- 3 **CONTROL CHARTS FOR VARIABLES - II:** Probability limits; Initiation of control charts; Trial control limits; Determination of aimed value of Process Setting; Rational method of sub grouping; control chart parameters; control limits and specification limits; Natural tolerance limits; Relationship of a process in control to upper and lower specification limits; process capability studies.
- 4 **CONTROL CHARTS FOR ATTRIBUTES:** Special control charts for variables; group control chart; arithmetic moving X-bar and R charts; Geometric moving chart; control chart with reject limits; steady trend in Process average with constant dispersion; trend chart with sloping limits; variable subgroup size.
- 5 **VARIABLES INSPECTION AND ATTRIBUTES INSPECTION:** Variables inspection and attributes inspection; Relative merits and demerits; control charts for Attributes; p chart and np chart; varying control limits; high defectives and low defectives; special severe test limits; C chart; U chart. Dodge demerit chart; Quality rating; CUSUM or Cumulative sum control chart; Average run length (ARL) Relative efficiency or sensitivity of control chart.
- 6 **ACCEPTANCE SAMPLING I:** Probability theory; binomial and Poisson distribution; Acceptance Inspection; 100% Inspection; No Inspection and sampling inspection; operating characteristic curve (O.C. Curve) Effect of sample size and Acceptance number; type A and type B O.C curves.
- 7 **ACCEPTANCE SAMPLING II:** Single. Double and multiple sampling plans; SS Plan; Acceptance/Rejection and Acceptance/Rectification Plans; Producers Risk and consumer's risk; Indifference Quality level; Average Outgoing quality (AOQ) curve; AOQL; quality protection offered by a sampling plan; Average sample number (ASN) curve; Average Total Inspection (ATI) curve

REFERENCE BOOKS

1. Grant E L; "Statistical Quality Control"; Richard Heavenworth; Dec 2000; TMH
2. Duncan AJ "Quality Control and Industrial Statistics; 4th ed. Pub- Richard Dirwin; 1974
3. Dale H Bestefield "Quality control"; Pearson Printice Hall/April 2008
4. Feigenboun AY "Total Quality Control" 4th ed. McGraw Hill Professional; August 2004
5. Burr IW; Dekkar M "Elementary SOL; Dhanpat Rai and Co; (P) Ltd. 2008
6. Mahajan M; "Statistical Quality Control" ; Dhanpat Rai and Co; (P) Ltd. 2008

ME-517	ARTIFICIAL INTELLIGENCE IN MANUFACTURING	L-T-P	Cr
		5-0-0	3

OBJECTIVE

To provide a strong foundation of fundamental concept in Artificial Intelligence; to provide a basic exposition to the goals and methods of Artificial intelligence; to enable the student to apply these techniques in applications which involve perception; reasoning and learning.

- 1 **HUMAN AND MACHINE INTELLIGENCE:** Concepts of fifth generation computing – Programming in AI environment; developing artificial intelligence system; natural language processing; neural networks.
- 2 **KNOWLEDGE REPRESENTATION FOR SMART SYSTEMS:** Forward chaining; backward chaining; use of probability and fuzzy logic. Semantic net structure and objects; ruled systems for semantic nets; certainty factors; automated learning.
- 3 **LANGUAGES USED IN AI:** Using PROLOG to design expert systems; converting rules to PROLOG; conceptual example; introduction to LISP; function evaluation; lists; predicates; rule creation.
- 4 **EXPERT SYSTEM DEVELOPMENT:** Definition – choice of domain; collection of knowledge base; selection of inference mechanism; case studies o expert system development in design and manufacturing.
- 5 **EXPERT SYSTEM TOOL:** Expert systems – controlling reasoning – rule based system canonical systems – rules and meta rules – associative nets and frame systems – graphs trees and networks – representing uncertainty – probability in expert systems – learning – forms of learning – inductive learning – decision trees – knowledge in learning – Heuristic classification – Heuristic matching.
- 6 **CASE STUDIES:** Case studies in expert system – MYCIN – Meta Dendral general structure of an expert system shell; examples of creation of an expert system using an expert system tool Fundamentals of object oriented programming; creating structure and object; object operations; invoking procedures; programming applications; object oriented expert system.
- 7 **INDUSTRIAL APPLICATION OF AI AND EXPERT SYSTEMS:** Robotic vision systems; image processing techniques; application to object recognition and inspection; automatic speech recognition.

REFERENCE BOOKS:

1. Robert Levine "A Comprehensive Guide to AI and Expert Systems": McGraw Hill Inc 1986
2. Henry C Mishkoff; "Understanding AI; BPB Publication; New Delhi 1986
3. Peter Jackson; "Introduction to Expert Systems" first Indian Reprint 2000 3rd Ed. Addison – Wesley
4. Stuart Russell and Peter Norvig; "Artificial Intelligence: A Modern Approach" Prentice Hall; 3rd ed. 1995
5. Elaine Rich et al "Artificial Intelligence" McGraw Hill 1995

- Winston P H "Artificial Intelligence" Addison-Wesley; Reading Massachusetts. Third Edition 1992

ME-521	FINITE ELEMENT METHOD	L-T-P	Cr
		5-1*-0	4

OBJECTIVE

To develop expertise on application of finite element techniques for mechanical system analysis, design and integration.

- INTRODUCTION:** Historical back ground; stress and equilibrium; boundary conditions; strain-displacement and stress-strain relations, temperature effects; potential energy and equilibrium; Rayleigh-Ritz Method; Galerkins method; saint Venat's principle, Von Mises stress.
- ONE-DIMENSIONAL FINITE ELEMENT MODELING:** Coordinates and shape functions; the potential energy approach; the Galerkins approach; assembly of the global stiffness matrix and load vector; the finite element equations; treatment of boundary conditions; quadratic shape functions, temperature Effects.
- PLANE TRUSSES:** Element stiffness matrix; stress calculations; temperature effects; three dimensional trusses; assembly of global stiffness matrix for the banded and skyline solutions.
- TWO DIMENSIONAL PROBLEMS:** Using constant strain triangular; isoparametric representation; potential energy approach; element stiffness; Galerkin approach; stress calculation temperature effects; problem modeling and boundary conditions; orthotropic materials; temperature effects.
- AXISYMMETRIC SOLIDS:** Subjected to axisymmetric loading; formulation; finite element modeling; triangular element; potential energy approach; rotating flywheel surface traction Galerkin approach; stress calculation temperature efforts cylinder subjected to internal pressure; press fit on rigid and elastic shafts.
- DYNAMIC CONSIDERATIONS:** Formulation; element mass matrices; Eigen values and eigenvectors evaluation generalized Jacobi method; tridiagonalization; implicit symmetric QR step with Wilkinson; shift for diagonalization; Guyan reduction.
- PREPROCESSING AND POST PROCESSING MESH GENERATION:** Post processing deformed configuration and mode shape contour plotting; nodal values from known constant element values; least Square fit for a four noded quadrilateral.

REFERENCE BOOKS

- Jungen, Bath Klaus, "Finite Element Procedures", Prentice Hall of India, 1997
- Chandru Patla, Tirupathi, R and Belegundu, Ashok D, "Introduction to Finite Elements in Engineering", Prentice Hall of India, 2000

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- Reddy, "An Introduction to the Finite Element Method", Second Ed., McGraw Hill
- Zienkiewicz, "The Finite Element Method", Third Ed., McGraw Hill.
- Rao, S.S., "The Finite Element Method Engineering", Third Ed, Butterworth Heinemann, 1999.
- DLxit, "Finite Element Methods for Engineers", Cengage Learning India

ME-522	PROPERTIES & SELECTION OF ENGG. MATERIALS	L-T-P	Cr
		5-1*-0	4

OBJECTIVE

To develop knowledge of different engineering materials, their properties and selection vis-à-vis applications.

- INTRODUCTION:** Classification of materials and structure of materials; structure property correlation.
- PROPERTIES OF MATERIALS:** Strength; ductility; toughness; stiffness; hardness; fracture toughness; fatigue strength; creep strength; oxidation resistance; corrosion resistance; friction and wear, weldability; etc.
- PROCESSING OF ENGINEERING MATERIALS:** Plain carbon steel and alloyed structural steels and stainless steels; high strength; high temperature materials.
- NON-FERROUS MATERIALS:** Properties and processing of non-ferrous materials Cu Alloys; Al-Alloys; Ti-Alloys; engineering ceramics.
- POLYMERIC MATERIALS:** Properties and processing of polymeric materials; metal matrix composites; polymer matrix composites; new materials.
- MATERIAL SELECTION PRINCIPLES:** Case studies in material selection, e.g. materials for structural applications; power plants; chemical plants; machineries; transport industries etc.
- SPECIAL APPLICATIONS:** Selection of Materials for aerospace applications; defense etc.

REFERENCE BOOKS

- Ashby, M.F., "Material Selection in Mechanical Design", Second Ed., Elsevier, 2001
- Sharma, "Engineering Materials Properties and Application of Metals and Alloys", Prentice Hall of India
- NIIT, "Properties and Application of Engineering Materials – Metals, Alloys, Polymers, Ceramics and Composites", NIIT, Prentice Hall of India
- Budinski, K.G. and Budinski, M.K., "Engineering Material Properties and Selection", Seventh Ed., Prentice Hall of India

ME-523	MACHINE TOOL DESIGN	L-T-P	Cr
		5-0-0	3

OBJECTIVE

To develop knowledge of analysis/design of machine tool using various techniques.

- 1 INTRODUCTION:** Kinematics of different types of machine tools; selection of cutting conditions and tools; calculation of cutting force on single point and multipoint tools; hole machining, calculation of power; accuracy requirements and standards.
- 2 DESIGN OF ROTARY DRIVES:** Design of spindle drives; AC motors with stepped drive; DC and AC variable speed drive motors characteristics and selection; principle of speed controllers; timing belts and other types of transmission belting, pulleys; closed loop operation of main drives; rotary indexing drives; design of feed drives: feed drive using feed boxes; axes feed drive of CNC drives; DC and AC servomotors.
- 3 CONTROLLERS:** Types, characteristics of controllers and their selection; ball screws and friction screws-guide ways; linear motion systems; design calculations of drives; closed-loop operations of feed drives; linear indexing drives; control elements: single and multi axis CNC controllers; hydraulic control, pneumatic control; limit switches; proximity switches; sequencing control using hard wired and PLC systems.
- 4 DESIGN OF MACHINE TOOL STRUCTURES:** Static and dynamic stiffness; dynamic analysis of cutting process; stability, forced vibration, ergonomics and aesthetics in machine tool design; design of spindle and spindle supports: function of spindles; design requirements; standard spindle noses; design calculations of spindles; bearing selection and mounting.
- 5 FINITE ELEMENTS ANALYSIS OF M/C TOOL STRUCTURES:** Examples of static; dynamic and thermal analysis and optimization of typical machine tool structures like column; table, Overarm; knee using a finite element analysis package.
- 6 DESIGN OF SPECIAL PURPOSE MACHINES:** Modular design concepts; standard modules.
- 7 DESIGN OF A TYPICAL SPM MACHINES:** Example; CNC and transfer machines.

REFERENCE BOOKS

1. Mehta, NK, "Machine Tool Design and Numerical Control" Tata McGraw Hill, 1996.
2. Koenigsberger F., "Design Principle of Cutting Machine Tools", Pergamon Press, 1964
3. Basu, SK and Pal, DK, "Design of Machine Tools", Fourth Ed., Oxford and IBH, 1995
4. Acherkan, N, "Machine Tool Design Vol I-IV", Mir Pub Moscow
5. Sen, G C and Bhattacharya, A, "Principals of Machine Tools", Second Ed., New Central Book Agency, 1975

ME-524	PRODUCT DESIGN	L-T-P	Cr
		5-0-0	3

OBJECTIVE

To develop knowledge on mechanical product design, material selection and application of latest techniques in design including computer techniques.

- 1 PRODUCT DESIGN PROCESS:** Importance, considerations of a good design; design morphology; designing to codes and standards technological innovation and design process; identification of customer needs; quality function deployment and product design specification.
- 2 CONCEPT GENERATION AND EVALUATION:** Creativity and problem solving; inventive problem solving; generating design concepts; axiomatic design evaluation methods; decision making; conceptual design; embodiment design and detail design; product architecture; configuration design.
- 3 MATERIALS IN DESIGN:** Materials solution process; economics of materials; methods of material selection; material performance Indices; decision matrices; value analysis; design for brittle fracture for fatigue failure and for corrosion resistance; design for assembly.
- 4 MATERIAL PROCESSING AND DESIGN:** Role of processing in design; factors determining process selection; design for manufacturability (DFM); designs for assembly (DFA); design for casting; forging sheet metal forming; machining; power metallurgy; welding; residual stresses in design; design for plastic processing.
- 5 NON-FERROUS MATERIALS:** Design of plastic and non-ferrous material components
- 6 DESIGN STRATEGIES:** Design for Reliability; failure mode and effect analysis techniques of failure analysis; design for safety; robust design; design optimization; economic decision making; cost benefit analysis.
- 7 DETAIL DESIGN:** Detail design and drawings; bill of materials; impact of CAE on detail design; design review.

REFERENCE BOOKS

1. Dieter, George E, "Engineering Design: A Materials and Processing Approach", Third ed., McGraw Hill, 2000
2. Ulrich, K.T. and Eppinger, S.D., "Product Design and Development", Third ed., Tata McGraw Hill, 2003
3. Otto, K and Wood, K., "Product Design Techniques in Reverse Engineering and New Product Development", Pearson 2001
4. Chitale, A.K. and Gupta, R.C., "Product Design and Manufacturing", Second ed., Prentice Hall of India, 2002
5. Parameswaran, M.A., "An Introduction to Design Engineering", Narosa 2004
6. Yousef, Haik, "Engineering Design Process", Thomson, 2003.

ME-525	WELDING AND ALLIED PROCESSES	L-T-P	Cr
		5-0-0	3

OBJECTIVE

The students are provided with an opportunity to acquire deeper knowledge of welding processes as regards to characteristics of welding machines, welding consumables, special welding processes and weldability of different material. After the course, the students will be in a position to manage a modern welding organization.

- INTRODUCTION:** Review of welding processes like gas; arc and resistance welding.
- WELDING POWER SOURCES:** Types of power sources; External V-I characteristics for constant current and constant voltage power sources; Rectifiers; Solid-state Rectifiers; Inverter systems; Duty cycle.
- ARC WELDING CONSUMABLES:** Types of electrodes; AWS and Indian system of classification and coding of covered electrode for mild steel; Shielding gases and associated mixtures. Metal transfer: Short circuit/ dip transfer; Free flight; Globular type; Spray type; Forces affecting metal transfer; Weld bead geometry and shape factors; Weld dilution.
- ARC WELDING PROCESSES:** Electric arc welding principle MIG welding equipment and processes; shielding gas; types of metal transfer. Tungsten inert gas arc welding (GTAW): - welding equipment; electrodes; inert gases and torches. Submerged arc welding (SAW):- principle of processes; applications; fluxes and welding electrodes used. CO₂ welding: - difference from MIG welding; Principle of operation; equipment; welding parameters and applications.
- SOLID STATE WELDING:** Introduction; main features and applications of Ultrasonic welding; Friction welding and Explosive welding. Welding of plastics: Difficulties in welding of Plastics; Processes for welding of Plastics.
- WELDABILITY OF SPECIFIC MATERIALS:** Stainless Steel; Aluminium and Cast Iron; Surfacing and metal spraying: Surfacing methods such as SMAW; MIG; TIG; SAW. Thermal spraying: Introduction; Procedures; Applications; Advantages and Disadvantages; Thermal cutting of metals: introduction; types; principle and operation of flame and plasma cutting.
- UNDER WATER WELDING:** Introduction; methods and applications Automation in Welding: Introduction; Semiautomatic welding; Automatic welding; Welding mechanization; Flexible Automated Welding; Robotic welding; Types of Welding Robots; Robot Selection Mechanics; Joint tracking system.

REFERENCE BOOKS

- Carry, H. B, "Modern welding technology" (PH). 6th Ed. Nov. 2004; Prentice Hall
- Richard, Little, "Welding and "Welding Technology" TMH, Aug 2001

- Parmar, R. S., "Welding Technology: Welding Engg & Technology", Khanna Publishers
- AWS, "Welding Handbook" (IV – VI) Edition by AWS

ME-526	FOUNDRY TECHNOLOGY	L-T-P	Cr
		5-0-0	3

OBJECTIVE

The students are provided with an opportunity to acquire deeper knowledge of foundry technology as regards to melting furnaces, mould design, special casting methods, quality and pollution control. After the course is completed, the students will be in a position to manage a modern foundry production unit.

- INTRODUCTION:** Items (Domestic and Engg.) made by foundry technology; advantage and limitations of foundry technology and other manufacturing processes; castability and factors favouring castability; Ferrous and Non ferrous casting metals and alloys and items made of them
- MELTING FURNACES:** Melting furnaces for cast iron; cast steels; aluminium alloys; brass and bronzes; Solidification of castings
- MOULD DESIGN:** Mold design considerations: Conceptual functional and production phase. Pattern and core design considerations; traffic rules applications; examples; case studies; Gating system elements: Objectives; practical rules; optimal time filling; types of pouring basin; types of gates; types of risers.
- SPECIAL CASTING METHODS :** Gravity die casting; cold chamber die casting; hot chamber die casting; investment casting; centrifugal casting; shell mold casting; continuous casting.
- FETTLING AND FINISHING:** Rough cleaning (Fettling) and surface cleaning of castings.
- INSPECTION and QUALITY CONTROL:** Casting inspection. Repair and salvage of castings; Quality control of castings.
- HEAT TREATMENT and POLLUTION CONTROL:** Heat treatment of castings Pollution control in foundry; Modernisation of foundry.

REFERENCE BOOKS

- Richard W.Heine ; Carl R Hoper; Philip C. Rosenthal "Principles of Metal casting"; Tata Mc Graw Hill
- Jain P. L. "Principles of Foundry Technology" Tata Mc Graw Hill 1995
- Salmon W.H; "Foundry Practice"
- Campbell J. S "Principles of Manufacturing Materials and Processes"; Tata Mc Graw Hill.2003
- Degnamo E. P. "Materials and Processes in Manufacturing by; McMillan publishing
- Sharma, P. C, "Production Technology", S. Chand and Co. Standard of metals (ASM) (Vol. 1-14)

ME-555	SIMULATION LAB	L T P	Cr
		0 0 4	2

LIST OF EXPERIMENTS

- Simulation of a single link, free robotic system(single link pendulum)
- Simulation of double pendulum-free and forced
- Forward and inverse simulation of a PLANAR three link robotic system
- Forward simulation of a 6-axis Puma Robot
- Simulation of lower-order mechanism for opening of a container latch
- Simulation of a higher order joint
- Simulation of vibration in a cable hoist
- Create a robotic model in the MATLAB environment with the predefined HD-parameters.
- Simulation of a 3-DOF planar robot with two joints revolute and one joint prismatic.
- Simulation of a beam vibrating in first two modes of vibrations.
- Simulation of a signal link pendulum considering the flexibility characteristics and structural dynamics of the link material.

Note: Atleast 10 experiments are to be performed from the above list.

REFERENCE BOOKS

- Amps Gilat "Matlab" "An Introduction with Application" 3rd Ed of Wiley Publication.
- Robert J Schilling, "Fundamentals of Robotics" Analysis and Control, Prentice Hall of India, 2004

ME-556	MECHANICAL ENGINEERING LAB-I	L-T-P	Cr
		0-0-4	2

LABORATORY WORK

Practice of transformation. Use of CAD package for developing typical objects using Boolean; and sweep operations on primitives; use of CAD models for other applications. Development of FEM models for Static/Dynamic analysis for a bar; beam and a shaft. Practice in using FEM software on other real life problems like spanners; connecting rods etc.

Coordinate transformations and Programming for synthesis of mechanisms. Forward and inverse kinematics of robot manipulators; programming for path and motion generation

ME-557	MECHANICAL ENGINEERING LAB-I	L-T-P	Cr
		0-0-4	2

LABORATORY WORK

Identification of angles and parameters of single point and multipoint cutting tools and their grinding. Identification of chip formation and cutting forces of different metals at different cutting conditions. Study of tool wear on center lathe and electro- discharge Machine (EDM). Study of surface finish produce by grinding machines and effects of using cutting fluids.

ME-570	MECHANICAL ENGINEERING LAB-II	L-T-P	Cr
		0-0-4	2

LABORATORY WORK

Experiments on Free and Forced; Undamped and Damped Vibrations of single and two degree of freedom systems; Vibration Absorber; Continuous Systems; Whirling of Shafts; Torsional systems.

Static and dynamic behavior of some important transducers; calibration procedure; development of computer aided experimentation systems. Experimental studies on Hydraulic; Pneumatic; Electrical controller; electromechanical actuators.

Use of MATLAB and LabView for the analysis of theoretical and experimental results.

REFERENCE BOOKS

- Amps Gilat "Matlab" "An Introduction with Application" 3rd ed of Wiley Publication.
- Rao SS "Mechanical Vibration" IV Edition, Pearson 2004
- Doeilter Ernest O "Measurement Systems Application and Design" Tata McGraw Hill, 1990

ME-579	MECHANICAL ENGINEERING LAB-III	L-T-P	Cr
		0-0-4	2

LABORATORY WORK

Development of FEM based computer programs for stress analysis of simple and complex mechanical equipment elements and vibration analysis of beams, plates and shafts etc. Use of software packages such as CATIA, SOLID WORKS, ANSYS or equivalent packages etc.

Mathematical Modelling and Programming of Manipulator kinematics.

REFERENCE BOOKS

- Schilling Robert J, "Fundamentals of Robotics" Analysis & Control, Prentice Hall of India, 2004
- Farid Amironche " Principles of Computer Aided Design and Manufacturing" 2nd Edition, Pearson Prentice Hall 2003

ME-580	SEMINAR-I	L-T-P	Cr
		0-0-2	1

The student has to undertake extensive literature survey on a topic with the approval of the course coordinator who shall not be below the rank of Assistant Professor. The work may involve extensive search of print, audio-video materials, internet surfing, etc.

The work of monitoring will be done by the course coordinator and evaluation by the course coordinator and the HOD or his nominee.

ME-601	MECHATRONICS PRODUCT DESIGN	L-T-P	Cr
		5-1*-0	4

OBJECTIVE

After learning the basics of Electronics and Analog and Digital Computers a student will be required to design components like sensors, actuators, etc. Finally he should be able to interface within digital computers.

- INTRODUCTION:** Introduction to mechatronic systems and components; principles of basic electronics; analog and digital.
- MICROPROCESSORS:** Programmable logic controllers (PLC); microprocessors and their applications; integrated circuits.
- HARDWARE:** Sensors; Actuators; and other electrical / electronic hardware in mechatronic systems; principles of electronic / system communication (PC Based).
- INTERFACING:** DA and AD converters; software and hardware principles and tools to build mechatronic systems.
- DESIGN OF MECHATRONIC COMPONENTS:** Design and selection of mechatronic elements namely sensors like encoders and revolvers; stepper and servomotors; ball screws; solenoid like actuators and controllers.
- DESIGN OF PRODUCTS:** Products for CNC systems; robotics and consumer electronics.
- CASE STUDIES:** Design and selection of elements for advanced applications relevant to the subject.

REFERENCE BOOKS

- Bolton, W, "Mechatronics", Addison Wesley, Second Ed., 1999
- AlciatoreP, DG and Histan MB, "Introduction to Mechatronics and Measurement System", Tata McGraw Hill, 2002

M.Tech. (ME)

- Shetty, Devdas, and Kolk, Richard A, "Mechatronics System Design", PWS Pub. Co., 1997.
- Venkataramana, C.R., "Mechatronics – Sensing to Implementation", S.B.S Publishers, 2001
- Stadler, Wolfram, "Analytical Robotics and Mechatronics", McGraw Hill, 1995
- HMT Ltd., "Mechatronics" Tata McGraw Hill, 1998

ME-602	CAD/CAM FOR MANUFACTURING	L-T-P	Cr
		5-1*-0	4

OBJECTIVE

In this course the students will be provided an opportunity to acquire deeper knowledge of CAD/CAM as regards to 2D and 3D transformation and manipulation, conversion of design data from one form to another to transfer the data to CNC and also to make programming for different jobs.

- TRANSFORMATION AND MANIPULATION OF OBJECTS:** Introduction; Transformation Matrix; 2D transformation; Arbitrary Rotation about the origin; Rotation by different angles; Concatenation; 2D transformation; Projection on to a 2D plane; Overall scaling; Rotation about an Arbitrary Point; 2D Reflection; 3D Transformation; 3D scaling; 3D Rotation of Objects; 3D Rotation about an arbitrary Axis; 3D Visualisation- reconstruction of Three Dimensional Images.
- DESCRIPTION OF CURVES AND SURFACES:** Line Fitting; Non Linear Curve Fitting with a Power Function; Curve Fitting with a High Order Polynomial; Chebyshev Polynomial Fit. Fourier Series of Discrete Systems; Cubic Splines; Parabolic Cubic Splines; Non Parametric Cubic Spline; Boundary Conditions; Bezier Curves; Differentiation of Bezier Curve Equations; B-Spline Curve; Non Uniform Rational B-Spline (NURBS); Surface creation; Coons patch; tensor product surfaces; Bezier surface; relational parametric surface; parametric spline surface; Lofted surfaces; spline blended surfaces; Tangent and Twisted vectors; Blended surfaces; Application Software; Solid Modeling; Introduction; solid models and entities; solid representation; regularised Boolean operation; Half- spaces; B-Rep and CSG modeling techniques; analytic solid modeling; solid manipulations.
- DATA EXCHANGE FORMATS:** Shape based formats; product data based formats; ISO standards; IGES- data representation; file structure and formats; processors; PDES- data representation; STEP- ARCHITECTURE AND IMPLEMENTATION; ACIS and DXF; creating IGES; STEP; ACIS and DXF files; Mechanical Assembly analysis: Assembly modeling- parts modeling and representation; Hierarchical relationships; Mating conditions; Representation schemes- Graph structure; location Graph; virtual link; generation of assembly sequences: precedence diagram; liaison sequencing analysis; precedence Graph; assembly analysis.

- 4 **HIDDEN LINE AND HIDDEN SURFACE REMOVAL ALGORITHMS** : Visibility techniques- mini-max test; containment test; surface test; edge interactions; homogeneity test; sorting; coherence; Warnock algorithm; The priority or z- Buffer algorithm; Watkinson Scan line algorithm; Ray tracing algorithm.
- 5 **PROCESS PLANNING**: activities; process plan development; CAPP; benefits of CAPP; architecture of CAPP; CAPP approaches- variant CAPP; generative CAPP; Hybrid CAPP; CAPP systems.
- 6 **PART PROGRAMMING** : preparing CAD data for NC; Machine tools-motion and Axis of machine Tools; point –to- point and continuous path machining; NC; CNC and DNC; NC programming- mathematics of Tool path; machining forces; Cutter programming; Tool offsets; G and M codes; APT programming; Tool path generation; Tool path verification.
- 7 **ADVANCES IN CAD/CAM**: CIM; Architecture; Objectives; CIM Implementation; Agile Manufacturing; Reverse Engineering; Concurrent Engineering; Rapid Prototyping; Virtual Manufacturing and Prototyping and Factory of the Future; The Enterprise and Product Modeling.

REFERENCES BOOKS:

1. Farid, Amirouche, "Principles of Computer Aided Design and Manufacturing", 2nd Edition, Pearson Prentice Hall, 2003
2. Ibrahim, Zeid, "CAD/CAM Theory and Practice", Tata McGraw Hill, 2009
3. Radhakrishnan, P., "CAD/CAM/CIM", New age international, 3rd ed., Oct 2007, reprint 2009
4. Rogers and Adams, "Mathematical Elements of Computer graphics", 2nd ed., WCB/McGraw Hill
5. Besant and Lui, "Computer Aided Design", Prentice Hall of India.
6. Yoram, Koram, "Computer control of manufacturing systems", McGraw Hill, 2005
7. Phalm, D.T, and Dinjoy, S.S, "Rapid Manufacturing", Springer Verlag, London, 2001

ME-604	DESIGNS OF MECHANISMS AND MANIPULATORS	L-T-P	Cr
		5-1-0	4

OBJECTIVE

To develop knowledge of kinematics, mechanisms, integration and analytic techniques to achieve optimum design. The focus is on design of Manipulators for automation and robotic actions.

- 1 **INTRODUCTION**: Classification of closed and open-loop kinematic systems; definition of mechanisms and manipulators; Kinematic constraints; degree of freedom (DOF) and mobility; Denavit Hartenberg parameters; coordinate transformations, matrix methods.
- 2 **STRUCTURAL MECHANISMS**: Analysis and synthesis of mechanisms.
- 3 **FORWARD AND INVERSE KINEMATICS**: Robot manipulators with examples.

- 4 **JACOBIAN AND SINGULARITY**: Alternative design solutions of mechanisms and manipulators.
- 5 **EVALUATION AND SELECTION OF OPTIMUM MECHANISM**: Type and number synthesis; design of mechanisms; indexes of merit, graphical, algebraic and optimization techniques.
- 6 **GENERATORS**: Design of function; path, and motion generators.
- 7 **DYNAMIC CONSIDERATIONS**: Rigid body dynamics, Newton-Euler formulation; equations of motion; methodologies for inverse and forward dynamics.

REFERENCE BOOKS

1. Uicker, J.J., Pennock GR, Shigley J, "Theory of Machines and Mechanism" Oxford, 2003.
2. Norton, R.L., "Design of Machinery, An Introduction to the Synthesis and Analysis of Mechanisms and Machines", Second Ed., McGraw Hill, 1999.
3. Ghosh, A and Malik, AK, "Theory of Machines and Mechanisms", Third Ed., Affiliated East West 1998.
4. Craig, J.J., "Introduction to Robotics, Mechanics and Control", Fourth Ed., Pearson 2003.
5. Schilling, Robert J, "Fundamentals of Robotics Analysis and Control", Prentice Hall of India, 2000
6. Mittal, R.K. and Nagrath, I.J, "Robotics and Control", Tata McGraw Hill 2003.
7. Malik, A.K., Ghosh, A and Diltrich, G., "Pneumatic Synthesis of Mechanisms", CRC Press, 1994.
8. Erdman, AG and Sander, GN, "Mechanism Design Analysis and Synthesis Vol. I", Prentice Hall, 1994
9. Yoshikawa, T., "Foundation of Robotics, Analysis and Control", Prentice Hall of India, 1998.
10. Sandor, G.N. and Erdmam, AG, "Advanced Mechanism Design, Analysis and Synthesis", Vol.2, Prentice Hall, 1994

ME-605	DESIGN, PLANNING AND CONTROL OF PRODUCTION SYSTEMS	L-T-P	Cr
		5-0-0	3

OBJECTIVE

The student is provided with an opportunity to acquire deeper knowledge of Production Systems and how to use production planning and control techniques in managing the working of a modern industry.

1. **INTRODUCTION TO PRODUCTION SYSTEMS**: Aim of production systems; generalized model and types of Production systems Features compiling service organization; Life cycle approach to production management.
2. **PRODUCT DEVELOPMENT AND DESIGN** : New Product development and process selection; stages in new product

development; use of decision tree; Breakeven Analysis; Make/buy decision; Problems for Break even Analysis Non linearity in B E Analysis.

- 3. PLANT LOCATION AND LAYOUT:** Selection of location among alternatives A case study; systematic layout planning; objectives; types; comparison and application of different types of layouts. Assembly line balancing concept and problems for maximum line efficiency.
- 4. PLANNING FOR PRODUCTION:** Importance; objectives and types of forecasting methods; Analysis and comparison standard error of estimate.
- 5. MATERIAL CONTROL:** Material Requirement Planning (MRP) objective; dependent demand; inputs to MRP; MRP model; Production schedule; MRP Logic comparison.
- 6. SEQUENCING AND SCHEDULING:** Criteria for sequencing; priority sequencing and rules; n job 2 machine; n job 3 machine; n job m machine problems.
- 7.** Elements of monitoring and follow up.

REFERENCE BOOKS:

1. Buffa, E S, "Production Operations Management", Wiley Series
2. Eilon, Samuel, A, "Elements of Production- Planning and Control" Pub Universal Publishing Corpn, 1999
3. Biejel, J., Jonne, Biegel, "Production Control: A quantitative approach", 2nd ed.
4. Martand, Telsang, "Industrial Engineering and Production Management", S Chand and Co. Ltd.
5. Joseph, Monks, "Operations Management – Theory and Problems", 3rd ed., Tata McGraw Hill
6. Sharma, P.C., "Production Engineering", S Chand and Co. Ltd., 10th Rev. Ed., 2005

ME-612	ADVANCED MECHANICAL DESIGN	L-T-P 5-1*-0	Cr 4
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OBJECTIVE

This course will enable students to design components based on real life situations, by including higher order factors like corrosion, fatigue etc.

- 1. INTRODUCTION:** Review of materials and processes for machine elements; case studies of mechanical engineering design failures;
- 2. STRENGTH CONSIDERATIONS IN DESIGN:** Review of static strength failure analysis theories of failure including von-Mises theory based strength design.
- 3. DESIGN FOR FATIGUE FAILURE:** High cycle and low cycle fatigue; fatigue strength design of mech; equipment elements; exercises of fatigue design of shafting and gears; surface fatigue design failures;

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exercises of surface fatigue design of rolling contact bearings including linear bearings.

- 4. STIFFNESS BASED DESIGN:** Design for creep; combined creep and fatigue failure prevention; design to prevent buckling and instability.
- 5. TRIBODESIGN:** Applications to design of sliding bearings and mechanical seals; selection of lubrication systems.
- 6. DESIGN FOR CORROSION:** Wear; Hydrogen embrittlement; fretting fatigue and other combined modes of mechanical failure.
- 7. DYNAMICALLY SOUND DESIGNS:** Design of machine elements like springs and shafts; introduction to dynamic design of mech; equipment and its implementation.

REFERENCE BOOKS

1. Shigley, J.E and Mischke, C.R., "Mechanical Design (in SI units)" Sixth Ed., McGraw Hill, 2003
2. Norton, Robert L, "Machine Design Integrated Approach" Second Edition, Pearson, 2000.
3. Spotts, M.F. Shoup, T.E, "Design of Machine Elements" Seventh Ed., Pearson, 1998.
4. Maleev and Hartman's (edited by O.P.Grover), "Machine Design in S.I. units", CBS, 1999.
5. Dieter, G, "Engineering Design, A Material and Processing Approach", McGraw Hill, 2000.
6. Dukkupati, RV, Ananda, Rao and Bhat, R, "Computer Aided Analysis and Design of Machine Elements", New Age, 2004

ME-613	AUTOMATION IN MANUFACTURING	L-T-P 5-1*-0	Cr 4
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OBJECTIVE

To provide a strong foundation in Automation in manufacturing; basic systems in automation; application of control systems in automation and modeling and simulation for manufacturing plant automation.

- 1 INTRODUCTION:** Automation in Production system; Principles and Strategies of Automation; Basic Elements of an Automated System; Advanced Automation Functions; Levels of automations; introduction to automation productivity.
- 2 MATERIAL HANDLING SYSTEMS:** Overview of Material Handling Systems–rotary feeders; oscillating force feeder; vibratory feeder; elevator type and centrifugal type feeders; Principles and Design consideration; Material Transport systems; storage systems.
- 3 AUTOMATED MANUFACTURING SYSTEMS :** Components; Classification and Overview of Manufacturing systems; Manufacturing Cells; GT and Cellular Manufacturing; FMS and its

Planning and Implementation; Flow lines and Transfer Mechanisms; Fundamentals and Analysis of Transfer Lines; product design for automatic assembly.

- 4 **CONTROL TECHNOLOGIES IN AUTOMATION:** Industrial Control Systems; Process Industries Verses Discrete Manufacturing Industries; Continuous Verses Discrete Control; Computer process and its Forms. Sensors; Actuators and other control system components.
- 5 **EVALUATION OF AUTOMATIC PRODUCTION:** Product manufacturability; orientation devices – active and passive devices; parts orientation and escapement and placement
- 6 **PNEUMATIC AND HYDRAULIC COMPONENTS AND CIRCUITS:** Boolean algebra; pneumatic sensors and amplifiers; jet destruction devices; logic devices; schimit triggering devices; developing pneumatic circuits for automatic die casting machine.
- 7 **MODELING AND SIMULATION FOR MANUFACTURING PLANT AUTOMATION:** Introduction; need for system modeling; building mathematical model of a manufacturing plant; modern fuzzy decision and control; robots and application of robots for automation.

REFERENCE BOOKS

- 1 Groover, M.P, "Automation; Production Systems and Computer Integrated Manufacturing", Prentice Hall of India Education, 2nd Ed., 2001
- 2 Dorf, R C, "Handbook of design; manufacturing and automation", John Wiley and Sons
- 3 David, W P, "Industrial Automation", John Wiley and Sons
- 4 Kant, Krishna, "Computer Based Industrial Control"; EEE Prentice Hall of India, Aug, 2004
- 5 Tan-Kuo, Chang, "An Introduction to Automated Process Planning Systems", Prentice Hall of India
- 6 Bruno, Lotter, "Manufacturing assembly handbook", Butterworth – Heinemann
- 7 Viswanandham, "Performance Modeling of Automated Manufacturing Systems" Prentice Hall of India
- 8 Hunter, RP, "Automatic process control system and hardware", Prentice Hall

ME-657	MECHANICAL ENGINEERING LAB-IV	L-T-P	Cr
		0-0-4	2

LABORATORY WORK

Laboratory work will include Design of Mechatronics products using ITI simulation x software, LabView. Experiments on programmable logic controllers (including programming) Micro-processors, including Hydraulic and

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Pneumatic actuators. Experiments on DA, AD convertors, Stepper motors, Servomotors. Fabrication of simple mechatronics products as Lab work.

ME -658	MECHANICAL ENGINEERING LAB-IV	L-T-P	Cr
		0-0-4	2

LABORATORY WORK

Development of general purpose codes to carry out rotation, orthographic projection, isometric projection, reflection about a plane etc.

Development of general purpose code to carry out curve fitting like Cubic Spline, Bezier curve etc; development of optimized tool path; solid modeling.

ME-660	DISSERTATION PRELIMINARY	L-T-P	Cr
		0-0-10	5

See note as given under course ME-668.

ME-661	SEMINAR-II	L-T-P	Cr
		0-0-4	2

The work of Dissertation Preliminary is to be presented by the student in the form of Seminars II.

The work of monitoring will be done by the guide and evaluation by the committee consisting of guide, course coordinator and the HOD or his nominee.

ME-665	DISSERTATION PHASE-I	L-T-P	Cr
		0-0-12	6

See note as given under course ME-668.

ME-666	MINOR PROJECT	L-T-P	Cr
		0-0-6	3

The student is required to do the design/fabrication/coding/simulation of equipment/process/system of his/her choice and to be approved by the course coordinator.

The course coordinator will evolve the evaluation procedure under the guidance of HOD.

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- **Lingaya's Institute of Health Sciences**
 - **Lingaya's Public School**
- **Lingaya's Lalita Devi Institute of Management & Sciences, New Delhi (I.P. University)**
- **Sri Viveka Institute of Technology, Vijayawada**



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