KUMARAGURUCOLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai)

COIMBATORE – 641049

REGULATIONS 2014

CURRICULUM AND SYLLABUS

3rd to 8th Semesters

BE MECHATRONICS ENGINEERING

DEPARTMENT OF MECHATRONICS ENGINEERING

KUMARAGURU COLLEGE OF TECHNOLOGY

COIMBATORE – 641 049.

Academic Regulations 2014

(Norms and Rules)

B.E. / B. Tech Programmes

(2014-2015 onwards)

KUMARAGURU COLLEGE OF TECHNOLOGY, COIMBATORE - 641 049.

REGULATIONS 2014

B.E. / B. Tech Programmes
CREDIT BASED SYSTEM (CBS)

These regulations are applicable to students admitted into B.E. / B. Tech Programmes from the academic year 2014 – 2015.

Preamble

India has become a permanent member of Washington Accord. As an educational institution we are adopting the "Outcome Based Education (OBE) Process" to ensure that the required outcomes (knowledge, skills and attitude / behavior) are acquired by the learners of a programme. With the OBE process in mind, our educational system has been framed to provide the needful scope for the learners through the CBS that will pave the path to strengthen their knowledge, skills and attitude / behavior.

The CBS offers flexibility to learners which include large number of electives, flexible pace for earning credits and audit courses.

The Objectives of CBS

- To offer the right blend of Core, General, Engineering Sciences & Technical Arts and Basic Science courses to facilitate the learners to acquire the needful outcomes.
- To facilitate students to earn extra credits.
- To elevate the level of knowledge, skills and attitude/behavior on par with the students across the globe.
- To offer programmes in an academic environment with purpose, the needful foundations, breadth (exposure for optimal learning) and professionalism.

1. Definitions and Nomenclature

1.1 University

University means the affiliating university, ANNA UNIVERSITY, CHENNAI

1.2 Institution

Institution means KUMARAGURU COLLEGE OF TECHNOLOGY, Coimbatore, an autonomous institution affiliated to Anna University, Chennai

1.3 Head of the Institution

Head of the Institution means the Principal of the institution who is responsible for all academic activities and for the implementation of relevant rules of this regulation.

1.4 Programme

Programme means Degree Programme i.e., B.E / B. Tech Degree Programme.

1.5 Branch

Branch means specialization or discipline of B.E / B. Tech Degree Programme, such as Civil Engineering, Textile Technology, etc.

1.6 Course

Every paper / subject of study offered by various departments is called a course. (e.g. Operations Research)

1.7 Curriculum

The various components / subjects / papers studied in each programme that provides appropriate outcomes (knowledge, skills and attitude/behavior) in the chosen branch is called curriculum.

1.8 Credits

Course work is measured in units called credit hours or simply credits. The number of periods or hours of a course per week is the number of credits for that course

The details of credit allocation is given in Table **1.**

Table 1

Nature of the Course	**Hours per Week**	**Credits**
Theory	3	3
	3+1 (Theory + tutorial)	4
Laboratory	2 or 3	1
Special Laboratory	4 to 6	2
Theory + Laboratory	2 (Theory) + 2 or 3(Laboratory)	3
Theory + Laboratory	3 (Theory) + 2(Laboratory)	4
Project Work (Eighth Semester)	18 (Minimum)	6

1.9 Total credits

The total number of credits a student earns during the course of study period is called the total credits. A Student must earn **185 – 190** credits (varies with the branch) for successful completion of the B.E. / B. Tech regular programme (**Eight** semesters) and **138-140** credits for lateral entry (**Six** semesters).

2. Admission

2.1 First Year B.E. / B. Tech and Lateral Entry

The norms for admission, eligibility criteria such as marks, number of attempts, physical fitness and mode of admission will be as prescribed by the University.

2.2 For students readmitted from **2009** Regulations and **2013** Regulations (due to discontinuation for different reasons) **to 2014** regulation, a normalization(equivalent) course committee will be

constituted by the Principal to decide the Courses exempted and additional Courses to be appeared by the concerned student.

3. Branches of Study

The following branches of study approved by the University are offered by the institution.

B.E. Degree Programmes

- Aeronautical Engineering
- Automobile Engineering
- Civil Engineering
- Computer Science and Engineering
- Electronics and Communication Engineering
- Electrical and Electronics Engineering
- Electronics and Instrumentation Engineering
- Mechanical Engineering
- Mechatronics Engineering

B.Tech Degree Programmes

- Biotechnology
- Information Technology
- Textile Technology
- Fashion Technology

4. Curriculum Structure

4.1 According to the National Board of Accreditation (NBA), India, for each undergraduate (UG) Programme, the curriculum has to be evolved after finalizing the Programme Educational Objectives (PEOs) and the corresponding Programme Outcomes (POs). The POs are to be specifically evolved by referring to the twelve Graduate Attributes (GAs) listed by NBA for undergraduate programmes. The curriculum that evolves should broadly ensure the achievement of the POs and thus the PEOs of the programme.

4.2 All India Council for Technical Education (AICTE), New Delhi in its "Model scheme of instructions and syllabus for UG engineering degree programmes" published during October 2012 has prescribed the following curriculum structure for UG E&T degree programmes.

S.No	Course Work – Subject Area	Range of Total Credits (%)		Suggested Breakdown of Credits (for total = 176) (No.)
		Minimum	Maximum	
1.	Humanities and Social Sciences (HS) including Management;	5	10	14
2.	Basic Sciences (BS) including Mathematics, Physics, Chemistry, Biology;	15	20	30
3.	Engineering Sciences (ES), including Materials, Workshop, Drawing, Basics of	15	20	30

	Electrical/Electronics/Mechanical/Computer Engineering, Instrumentation;			
4.	Professional Subjects-Core (PC), relevant to the chosen specialization/branch; (May be split into Hard (no choice) and Soft (with choice), if required;)	30	40	50
5.	Professional Subjects – Electives (PE), relevant to the chosen specialization / branch;	10	15	20
6.	Open Subjects – Electives (OE), from other technical and / or emerging subject areas;	5	10	12
7.	Project Work, Seminar and/or Internship in Industry or elsewhere	10	15	20
8.	Mandatory Courses (MC);	Limited to less than 5% of the maximum permissible courses / credit load		8

The suggested Course Work (=176 Credits, at 22/Semester on an average with built-in flexibility of +/- 20% as indicated earlier) in previous table needs to be completed successfully by a student to qualify for the award of the UG E&T Degree from the concerned University/Institution. A widely accepted plan for sequencing the Course Work can be as in following table.

Typical Sequencing Plan for Courses at UG E&T Degree Programmes

Semesters	Subject Area Coverage
I – II	HS, BS and ES Courses common for all Branches; Mandatory Courses;
III-IV	HS, BS and ES Courses common for all Branches (to be continued); Also, Mandatory Courses (to be continued, if required); PC (Hard/Soft) Courses in two/three groups (likeElectrical, Non-Electrical); area wise Orientation; Add-On Courses;
V-VII	PC (Hard/Soft), PE and OE Courses; Branch-wise Orientation; Add-On Courses; Seminar;
VIII	PE and OE Courses; Project work and Dissertation, Internship, Seminar: Add-On Courses; Final wrap-up of Programme;

The mandatory courses for all the programmes prescribed by AICTE are shown in the following table.

Mandatory Courses (MC)

S.No	Course No.	Course Title	Hrs/Wk L: T: P	Units	Preferred Semester
1.	MC 01	Technical English	3: 0: 0	3	I/II
2.	MC 02	Value Education, Human	3: 0: 0	3	I/II

		Rights and Legislative Procedures			
3.	MC 03	Environmental Studies	3: 0: 0	3	III/IV
4.	MC 04	Energy Studies	3: 0: 0	3	III/IV
5.	MC 05	Technical Communication & Soft Skills	3: 0: 0	3	V/VI
6.	MC 06	Foreign Language	3: 0: 0	3	V/VI

NOTE: As and when AICTE brings in a new version of the "Model scheme of instructions and syllabus for UG engineering degree programmes", the existing version will be superseded by the new one.

4.3 Semester Curriculum

The curriculum of each semester shall normally be a blend of theory courses not exceeding **7** and practical courses not exceeding **4.** The total number of courses per semester shall not exceed **10**.

4.4 Medium of Instruction

The medium of instruction for lectures, examinations and project work is English, except for language courses other than English.

5. Duration of the Programme

5.1 Each academic year will consist of **Two** semesters of **90** working days each

5.2 The normal and maximum permissible number of semesters for each programme is as given in **Table 2**.

Table 2.

Category	**Number of Semesters**	
	Normal	**Maximum Permissible**
Regular	8	14
Lateral Entry	6	12

6. Class advisor and Ward Counselor (Mentor)

6.1 Class advisor

Head of the Department will allot one faculty member to be the class advisor for a particular batch of students throughout their period of study. The role of class advisors is as follows: i) To motivate and closely monitor the performance of the students. ii) To build a strong alumni base for the institution by maintaining a meaningful

rapport with students and parents. iii) To maintain all important documents of the students for reference/inspection by all committees. iv) To work closely with the ward counselors on matters related to students attached to the ward counselors and update the green cards (overall data base) of the students of the class.

6.2 Ward Counselor (Mentor)

By guiding and counseling students, teachers can create a greater sense of belongingness amongst our student community. To help the students in planning their courses and for general guidance on the academic programme, the Head of the Department will allot a certain number of students to a teacher of the department who shall function as ward counselor throughout their period of study.

The ward counselor will monitor the courses undertaken by the students, check attendance and progress of the students and counsel them periodically. The ward counselors should ensure that each student is made aware of the various options for growth, students are monitored and guided to become overall performers and students select and work for career choices of their interest. The ward counselors shall update and maintain the ward counselor record of each student attached to them. The ward counselors shall also help the class advisors to update the green card of students attached to them.

The ward counselor may also discuss with the class advisor and HoD and parents about the progress of the students.

7. Class Committee

7.1 Every class will have a class committee constituted by the HoD. The members of the class committee will be as follows:-

1. Chairperson (a teacher who is not normally teaching any course for the class)
2. All teachers handling courses for the class
3. Students (a minimum of **6** consisting of **3** boys and **3** girls on pro-rata basis)

7.2 The functions of the class committee shall include the following.

7.2.1 Clarify the regulations of the programme and the details of rules therein.

7.2.2 Inform the student representatives, the academic schedule including the dates of assessments and the syllabus coverage for each assessment.

7.2.3 Inform the student representatives the details of Regulations regarding weightage used for each assessment. In the case of practical courses (laboratory/ drawing / project work / seminar etc.) the breakup of marks for each experiment / exercise / module of work, should be clearly discussed in the class committee meeting and informed to the students.

7.2.4 Analyze the performance of the students of the class after each test and initiate steps for improvement.

7.2.5 Identify slow learners, if any, and request the teachers concerned to provide additional help / guidance / coaching to such students.

7.2.6 Discuss and sort out problems experienced by students in the class room and in the laboratories.

7.3 The class committee shall be constituted within the first week of commencement of any semester.

7.4 The chairperson of the class committee may invite the class advisor / ward counselor and the Head of the Department to the meeting of the class committee.

7.5 The Principal may participate in any class committee meeting.

7.6 The chairperson is required to prepare the minutes of every meeting, submit the same through the Head of the Department to the Principal within two days of the meeting and arrange to circulate the same among the students and teachers concerned. Points requiring action by the management shall be brought to the notice of the management by the Principal.

7.7 The class committee meetings are to be conducted as scheduled below.

Meeting 1	Within one week from the date of commencement of the semester
Meeting 2	One week before the 2nd internal test
Meeting 3	One week before the 3rd internal test

During the first meeting of the class committee, the students are to be informed about the nature and weightage of assessments as per the framework of the Regulations. During these meetings the student representatives shall meaningfully interact and express opinions and suggestions of the students of the class to improve the effectiveness of the teaching-learning process.

8. Course Committee for Common Courses

Each common theory course offered to more than one class / branch shall have a Course Committee comprising all the teachers teaching the common course with one of them nominated as Course Coordinator.

Sl.No	Nature of common course	Person responsible for forming course committee and nominating course coordinator
1.	For common course / course handled in a particular department	Respective HoD
2.	For common courses handled in more than one department	Controller of Examinations (CoE) to put up the course committee details to the Principal, get the same approved and intimate the concerned faculty

The course committee will ensure that a common question paper is prepared for the tests / exams and uniform evaluation is carried out. The Course committee will meet a minimum of 3 times in each semester.

The course committee should meet at-least 3 times in each semester The schedule for the course committee to meet is as follows.

Meeting 1	Before one week of the start of the semester
Meeting 2	One week before internal test 2
Meeting 3	One week after 3rd internal test

9. Requirements for Completion of a Semester

9.1 A student who has fulfilled the following conditions shall be deemed to have satisfied the requirements for completion of a semester.

9.1.1 Student should have earned a minimum of **80%** overall attendance in theory and laboratory courses. If a student fails to secure the minimum overall attendance of **80%**, he / she will not be permitted to appear for the current end semester examination and also to go to the subsequent semester. They are required to repeat the incomplete semester in the next academic year.

Note: All students are expected to attend all classes and secure 100**%** attendance. The above provision is made to allow for unavoidable reasons such as medical leave / participation in sports, NCC activities, co-curricular and extra-curricular activities.

Note: Faculty members have to mark attendance as ***'present'*** only for those students who are ***physically present*** in the class.

9.1.2 A maximum of **10%** concession in the overall attendance can be considered for students on medical reasons.

9.1.3 The need to award On Duty (OD) is eliminated as the student shall benefit from the 20% margin in attendance to take part in co-curricular and extra-curricular activities.

Apart from 20% margin in attendance, an additional 5% relaxation in attendance shall be provided after being recommended by a central committee constituting the Class Advisor, an ASP/AP from the Department and two Professors nominated by the Principal for the following categories.

i) NCC, NSS

ii) Sports (in the beginning of the year the Physical Director should give the list of students who are in the institution team and who will represent the institution in sports events)

iii) Design competitions-state level and above

A student shall not benefit from the above privilege if the student has been recommended for disciplinary action due to inappropriate or disruptive behavior. Minimum 80% overall attendance will be the only attendance eligibility to appear for end semester exams for such students.

9.1.4 The days of suspension of a student on disciplinary grounds will be considered as days of absence for calculating the overall percentage of attendance.

10. Requirements for Appearing for End Semester Examination

10.1 A Student who has fulfilled the following requirements will be eligible to appear for End Semester Exam.

10.1.1 Attendance requirements as per Clause Nos.9

10.1.2 Registration for all eligible courses in the current semester and arrear examination (wherever applicable).

Note: Students who do not register as given in clause 10.1.2 will not be permitted to proceed to the subsequent semester.

10.2 Retests should be permitted only very rarely for genuine reasons with the approval of HoD and Principal. Such tests will be conducted before the last day of instruction of the concerned semester. Retest is not permitted for improvement.

10.3. There will be no minimum CAM requirement in a course from 2014 regulation onwards to register for the end semester examinations. CAM will be earned by a student as follows:

Theory Courses:

Internal marks will be awarded by conducting Three Internal Tests and assignments for all theory courses.

Practical Courses:

Internal marks will be awarded by:

i) "Continuous assessment" of the performance of the student in each lab exercise/experiment.

ii) Conducting one model practical exam for every practical course.

Note: The students will be provided with a laboratory workbook and this will be the only document the student will maintain / get assessed periodically.

Retests:

A student who has not appeared for any one of the three internal tests (theory courses) shall be permitted to appear for a Retest (only one retest is permitted) only under the following two cases:

Case 1: Automatic exemption: Participation in NCC, NSS, Sports (in the beginning of the year the Physical Director should give the list of students who are in the institution team and who will represent the institution in sports events) or demise of immediate family members.

Case 2: Any other reasons: A committee constituting 1 professor, 1 ASP/AP and Class Advisor will scrutinize the case and submit their recommendations to the HoD, who in turn will forward the proposal to the Principal, get the approval and conduct retest. In case the retest is required by more than 10% of the students of a section, a review by a central committee and approval is required.

10.5 If a student is prevented to register in the end semester examinations for want of minimum overall attendance , the student is required to repeat the incomplete semester in the subsequent academic year.

10.5.1 If a student fails to clear a course in four attempts in a particular course through supplementary/end semester exams, the CAM of that course is nullified in the fifth attempt and the student will be allowed to appear for end semester examination and based on the student's performance in the end semester exam alone the result will be declared (that is, the student has to score a minimum of 50 out of 100 in the end semester exam for being declared to have passed in that course).

11. Provision for Withdrawal from Examination

A student may, for valid reasons (medically unfit / unexpected family situations), be granted permission to withdraw (after registering for the examinations) from appearing for any course or courses in the end semester examination. This facility can be availed only once during the entire duration of the degree programme. Withdrawal of application will be valid only if the student is, otherwise, eligible to write the examination and the application for withdrawal is made prior to the examination in the concerned course or courses. The application for withdrawal should be recommended by the Head of the Department and approved by the Principal. Withdrawal will not be considered as appearance for the purpose of classification of degree under **Clause 19.**

12. System of Evaluation

12.1 General Guidelines

The total marks for each course (Theory and Practical) will be 100, comprising two components as given below.

a) Continuous Assessment Marks (CAM) – 50 Marks

b) End Semester Exam (ESM) – 50 Marks

12.2 Marks distribution

12.2.1 Procedure for award of Continuous Assessment Marks (CAM) is as follows:

i. Theory courses

The distribution of marks for theory courses is given in **Tables 3 and 4**.

Table-3

S. No.	Components for CAM	Syllabus Coverage for the test	Duration of the test in Hrs.	Marks (max.)	Question Paper Pattern (Three patterns have been listed. The selection of the pattern to be decided by the faculty handling the course)
01.	Internal Test - I	First 30 to 40 % of the syllabus	2	40 (equal weightage for all the three tests)	**PATTERN – 1** **Part A** - 10x1 = 10 Marks Q.No.-1 to 10 Multiple choice questions (multiple choice, multiple selection, sequencing type, match the following, assertion – reason type) **Part B** - 05x2 = 10 Marks Q.No.-11 to 15 (Short Answer) **Part C** - 03x10 = 30 Marks Q.No.-16 - compulsory Q.No.-17, 18,19 (any two to be answered) **Case studies, analytical questions, design or evaluation or analysis or application oriented questions to be given in part C** **Total = 50 Marks** --- **PATTERN - 2** **Multiple choice questions only** 50x1 = 50 Marks Q.No.-1 to 50 (multiple choice, multiple selection, sequencing type, match the following, assertion – reason type) **Total = 50 Marks** --- **PATTERN – 3** **Part A** - 20x1 = 20 Marks Q.No.-1 to 20 Multiple choice questions (multiple choice, multiple selection, sequencing type, match the following, assertion – reason type) **Part B** - 2x15 = 30 Marks Q.No.-21- Compulsory Q.No.-22 and 23 (any one to be answered) **Case studies, analytical questions, design or evaluation or analysis or application oriented questions to be given in part B** **Total = 50 Marks** --- **Note:** *HOTS* of Bloom's taxonomy to be followed where applicable in all the patterns
02.	Internal Test - II	Next 30 to 40 % of the syllabus	2		
03.	Internal Test - III	Last 30 to 40 % of the syllabus	2		
04.	Retest (only one)	First 15 to 20 % and Last 15 to 20 % of the syllabus	2	Same weightage as **one** internal test	
05.	Assignment	-	-	10	Process for awarding marks for assignments shall be based on ***any one*** of the following: i) 2 Assignments ii) 1 Assignment + 1 presentation iii) 1 Assignment + 2 Written Objective test iv) 1 mini project

06.	Attendance (Refer clause-12.2.1(iv))	Attendance will not contribute to CAM of a course	--		
Total				**50**	

Pattern for end semester examination:

Table-4

S. No.	**Exam**	**Syllabus Coverage for the exam**	**Duration of the exam in Hrs.**	**Marks (max.)**	**Question Paper Pattern**
04.	End Semester Exam	Full Syllabus	3	50	**Part A** - 10x1 = 10 Marks Q.No.-1 to 10 Multiple choice questions (multiple choice, multiple selection, sequencing type, match the following, assertion – reason type) **Part B** - 10x2 = 20 Marks Q.No.-11 to 20 Short Answer **Part C** - 05x14 = 70 Marks Q.No.-21 -compulsory Q.No.-22 to 26 (any four to be answered) **Case studies, analytical questions, design or evaluation or analysis or application oriented questions to be given in part C** **Note:** *HOTS* of Bloom's taxonomy to be followed where applicable **Total = 100 Marks**
Total				**50**	

ii. Practical Courses

Every practical exercise / experiment in all practical courses will be evaluated based on the conduct of exercise / experiment and records maintained by the students. There will be one model practical examination.

The criteria for awarding marks for internal assessment is given in **Table 5**.

Table - 5

Items	Marks (Maximum)
Continuous assessment #	30
Model practical exams	20
Attendance { Refer-12.1(iv) }	-
Total	**50**

Continuous assessment norms (for each exercise/experiment):

Parameter	Range
1.Preparation	10 to 20%
2.Conduct of the exercise/experiment	20 to 30%
3.Observations made (data collection)	10 to 30%
4.Calculations, inferences, result	10 to 30%
5. Viva-voce	10 to 20%
Total	**100**

iii) (a) Project Work

The project will be carried out in two phases as follows: Phase-I in 7th semester and Phase-II in 8th semester. Separate project reports are to be submitted for phase-I and phase-II. Phase-I will purely be assessed internally.

The evaluation of the project work done by the student will be carried out by a committee constituted by the Principal on the recommendation of HoD. For each programme one such review committee will be constituted. There will be 3 assessments (each for 100 mark maximum) during the semester by the review committee. The student shall make a presentation on the progress made by him / her before the committee. There will be equal weightage for all the three assessments.

iii) (b) Technical Seminar & Mini Project:

These courses will be evaluated internally

iv) Attendance and assessment record

Every teacher is required to maintain an 'ATTENDANCE AND ASSESSMENT RECORD' for each course handled, which consists of students attendance in each lecture / practical / project work class, the test marks and the record of class work (topics covered). This should be submitted to the Head of the Department periodically (at least three times in a semester) for checking the syllabus coverage and the records of test marks and attendance. The HoD after due verification will sign the above record. At the end of the semester, the record should be submitted to the Principal for verification. After such verification, these records will be kept in safe custody by the respective HoD for five years.

Minimum overall attendance of 80% will be an eligibility criterion to take up end semester examinations and attendance will not contribute to CAM of a course.

12.2.2 End Semester Examination

(a) Theory Courses

The End Semester Examination for theory courses will be conducted with the pattern of Question Paper and duration as stated in Table 3(b) under clause 12.2. The evaluation will be for 100 **marks**. However, the question paper pattern for courses in engineering graphics and machine drawing will be designed differently to suit the specific need of the courses.

(b) Practical Courses

End semester examination for practical courses will be conducted jointly by one internal examiner and one external examiner appointed by the Controller of Examinations with the approval of the Principal.

The evaluation will be for **100** marks and the weightage for End Semester Practical Course will be **50.**

(C) Question Paper setting (ESM)

50% of theory courses in a semester will be randomly selected for setting question papers by External Examiners with sound knowledge in Revised Bloom's Taxonomy by the Controller of Examination. Head of the Department will give internal list of panel of examiners to set question papers in the remaining 50% of the theory courses.

(D) Evaluation of Answer Book

50% of theory courses in a semester will be randomly selected by the Controller of Examination for evaluation by External Examiners. Head of the Department will nominate senior faculty to evaluate the answer books in the remaining 50% of the theory courses.

12.3 Malpractice

If a student indulges in malpractice in any internal test / end semester examination, he / she shall be liable for punitive action as prescribed by the University.

12.4 Supplementary Examination

The arrear course (practical / theory) examinations of ODD semesters will be conducted soon after the publication of ODD semester regular exam (Nov / Dec) results. Similarly the arrear course examinations of EVEN semesters will be conducted soon after the publication of EVEN semester regular exam (April / May) results. Failed candidates in regular examinations **should compulsorily register** for all the practical / theory courses in the supplementary examinations.

The institution will conduct only the exams for the odd semester courses (one regular exam + one supplementary exam for arrears of the odd semesters) during November / December and will conduct only the exams for the even semester courses (one regular exam + one supplementary exam for arrears of the even semesters) during April / May of an academic year.

Students who have completed the eighth semester will be eligible for attending the **special supplementary exam** for all semester arrear papers (from 1^{st} to 8^{th} semesters) in the even semester examination session soon after their eighth semester regular examination results. Students who have **more than six arrears are not eligible** to appear for the special supplementary exam.

Controller of Examination (CoE) will publish a schedule of supplementary examinations after the last date of registering for the examinations. The pattern of evaluation will be the same as that of end semester examinations.

The revaluation of answer script will not be applicable for supplementary exam. However challenge of evaluation of answer script is allowed. The Arrear examination will be termed as supplementary examinations and such appearance in supplementary exam will be treated as another attempt and will be reflected in the grade sheet

Note: Refer clause 14 for procedure for re-totaling / revaluation / challenge of evaluation

12.5 A student who has appeared and passed any course is not permitted to re-enroll / reappear in the course / exam for the purpose of improvement of the grades.

13. Pass Minimum

13.1 Pass minimum for each theory, practical courses and project work is

- **50%** in the end semester examinations
- **minimum 50%** of the grand total of continuous assessment marks and end semester examinations marks put together

13.2 For students scoring less than the passing minimum marks in the end semester examinations, the term "**RA**" against the concerned course will be indicated in the grade sheet. The student has to reappear in the subsequent examinations for the concerned course as arrears.

For a student who is absent for theory / practical / project viva- voce, the term **"AB"** will be indicated against the corresponding course. The student should reappear for the end semester examination of that course as arrear in the subsequent semester.

The letter grade **"W"** will be indicated for the courses for which the student has been granted authorized withdrawal (**refer clause 11**).

14. Methods for Redressal of Grievances in Evaluation

Students who are not satisfied with the grades awarded can seek redressal by the methods given in **Table 6.**

Table 6

Note: All applications to be made to CoE along with the payment of the prescribed fee.

<table>
<tr><th rowspan="2">Sl.No.</th><th rowspan="2">Redressal Sought</th><th colspan="2">Methodology</th></tr>
<tr><th>Regular exam</th><th>Arrear exam</th></tr>
<tr><td rowspan="2">1.</td><td rowspan="2">Re totaling</td><td>Apply for photo copy of answer book / Then apply for re totaling</td><td>Apply for photo copy of answer book / Then apply for re totaling</td></tr>
<tr><td colspan="2">(within 5 days of declaration of result)</td></tr>
<tr><td rowspan="2">2.</td><td rowspan="2">Revaluation</td><td>Apply for photo copy of answer book / Then apply for revaluation after course expert recommendation</td><td rowspan="2">Not permitted</td></tr>
<tr><td>(within 5 days of declaration of result)</td></tr>
</table>

3.	Challenge of evaluation	Apply for photo copy of answer book / Then apply for revaluation after course expert recommendation / Next apply for challenge of evaluation	Apply for photo copy of answer book / Then apply for challenge of evaluation after course expert recommendation
		(within 3 days of publication of revaluation results)	

These are applicable only for theory courses in regular and arrear end semester examinations.

14.1 Challenge of Evaluation

a) A student can make an appeal to the CoE for the review of answer scripts after paying the prescribed fee.

b) CoE will issue the photo copy of answer script to the student.

c) The faculty who had handled the subject will evaluate the script and HoD will recommend.

d) A Committee consisting of 2 experts appointed by CoE will review and declare the result.

f) If the result is in favour of the student, the fee collected will be refunded to the student.

h) The final mark will be announced by CoE.

15. Classification of Performance

Classification of performance of students in the examinations pertaining to the courses in a programme is done on the basis of numerical value of Cumulative Grade Point Average **(CGPA).** The concept of **CGPA** is based on Marks, Credits, Grade and Grade points assigned for different mark ranges. **Table 7** shows the relation between the range of marks, Grades and Grade points assigned against each course.

Table 7

Range of Marks	Grade	Grade Points (GP)
100 - 90	S – Outstanding	10
89 - 80	A – Excellent	9
79 - 70	B - Very Good	8
69 - 60	C - Good	7
59 - 55	D – Fair	6
54 – 50	E – Average	5
< 50	RA	0
Withdrawal from examination	W	-
Absent	AB	-

15.1 Semester Grade Point Average (SGPA)

On completion of a semester, each student is assigned a Semester Grade Point Average which is computed as below for all courses registered by the student during that semester.

$$\text{Semester Grade Point Average} = \sum (C_i \times GP_i) / \sum C_i$$

Where C_i is the credit for a course in that semester and GP_i is the Grade Point earned by the student for that course.

The **SGPA** is rounded off to two decimals.

15.2 Cumulative Grade Point Average (CGPA)

The overall performance of a student at any stage of the Degree programme is evaluated by the Cumulative Grade Point Average **(CGPA)** up to that point of time.

$$\text{Cumulative Grade Point Average} = \sum (C_i \times GP_i) / \sum C_I$$

Where C_i is the credit for each course in each of the completed semesters at that stage and GP_i is the grade point earned by the student for that course.

The **CGPA** is rounded off to two decimals.

16. Issue of Grade Sheets

16.1 Separate grade sheet for each semester will be given to the students by the CoE after the publication of the results.

16.2 After the completion of the programme, a consolidated grade sheet will be issued to the student.

16.3 No separate grade sheet for supplementary examination/special supplementary examination will be issued to the students by the CoE after the publication of supplementary examination/special supplementary examination result.

The result of the supplementary examination will get reflected in the subsequent semester grade sheet. The result of the special supplementary examination will get reflected only in the consolidated statement of grade (that is, consolidated grade sheet).

17. Temporary Break of Study from a Programme

17.1 Break of study is not normally permitted. However, if a student intends to temporarily discontinue the programme in the middle of a semester / year for valid reasons (such as accident or

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hospitalization due to prolonged ill health) and wish to rejoin the programme in the next year, he / she shall apply in advance to the Principal through the Head of the Department stating the reasons. The application shall be submitted not later than the last date for registering for the semester examinations in that concerned semester. Break of study is permitted only once during the entire period of the degree programme.

17.2 The student permitted to rejoin the programme after the break shall be governed by the rules and regulations in force at the time of rejoining.

17.3 The duration specified for passing all the courses for the purpose of classification of degree (vide Clause **19**) shall be increased by the period of such break of study permitted.

17.4 If a student is detained for want of requisite attendance, progress and good conduct, the period spent in that semester shall not be considered as permitted Break of Study and Clause 17.3 is not applicable for this case.

18. Eligibility for the Award of Degree

A student shall be declared to be eligible for the award of the B.E. / B. Tech. Degree provided the student has successfully completed the course requirements and has passed all the prescribed examinations in all the Eight semesters **(Six** semester for lateral entry) within a maximum period of **7** years (**6** years for lateral entry) reckoned from the commencement of the first semester to which the candidate was admitted.

19. Classification of Degree

The degree awarded to eligible students will be classified as given in **Table 8.**

Table 8

S.No.	Class Awarded	Criteria
01.	First class with distinction	a) Passing of the examinations of all the courses in all Eight semesters (for regular) and all Six semesters (for lateral entry) in the first appearance. b) CGPA > 8.5 c) One year authorized break of study (Clause 17) and one authorized withdrawal (Clause 11) is permissible.

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02.	First class	a) Passing of the examinations of all the courses in all Eight semesters (for regular) and all Six semesters (for lateral entry student) within a maximum of Ten semesters for regular and a maximum of Eight semesters for lateral entry students. b) CGPA > 6.5 c) One year authorized break of study (Clause 17) and one authorized withdrawal (Clause 11) is permissible.
03.	Second class	a) All other students (not covered in clauses at S.No.1& 2 under Clause 19) who qualify for the award of the degree (vide clause 18) shall be declared to have passed the examination in Second Class.

Note: A student who is absent for the end semester examination in a course / project work Viva Voce after having registered for the same will be considered to have appeared for that examination for the purpose of classification.

20. Award of Degree

The award of Degree to all eligible students will be approved by the Academic Council of the institution. The degree will be issued by Anna University Chennai. The consolidated Grade Sheet will be issued by institution.

21. Industrial Visit

Every student is expected to undertake one local Industrial visit during the 2nd, 3rd and 4th year of the programme. The Faculty Advisor in consultation with the Head of the Department will organize the visit. Faculty should accompany the students during Industrial visits.

22. Personality and Character Development

All students shall enroll, on admission, in any one of the personality and character development programmes (NCC / NSS / NSO / YRC) and undergo training for about 80 hours and attend a camp of about ten days. The training shall include classes on hygiene and health awareness and also training in first-aid.

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- National Cadet Corps (NCC) will have about 20 parades.
- National Service Scheme (NSS) will have social service activities in and around the institution.
- National Sports Organization (NSO) will have Sports, Games, Drills and Physical exercises.
- Youth Red Cross (YRC) will have activities related to social services in and around institution. However, YRC will not have special camps of 10 days. While the training activities will normally be during weekends, the camps will normally be during vacation period.

Every student shall put in a minimum of **75%** attendance in the training and attend the camp (except YRC) compulsorily. The training and camp (except YRC) shall be completed during the first year of the programme. However, for valid reasons, the Principal may permit a student to complete this requirement in the second year.

23. Discipline

Every student is required to be disciplined and maintain decorum both inside and outside the institution campus. They should not indulge in any activity which can bring down the reputation of the University or institution. The Principal shall refer any act of indiscipline by students to the discipline and welfare committee.

24. Special Provisions

24.1 Option for Elective Courses

A student can have the option of taking 2 elective courses from other departments (maximum of one per semester)

24.2 Fast Track Programme

Students who maintain a CGPA of greater than or equal to 8.5 at the end of fourth semester and have passed all courses in first appearance (from semester 1 to semester 4 for regular category / semester 3 to semester 4 for Lateral Entry) are eligible for a fast track programme. Students can opt for the fast track programme from the Fifth Semester. The three elective courses of the

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eighth semester can be taken in the earlier semesters (maximum one per semester) by the students. This will enable the students to be completely free from theory courses in the Eighth Semester. Students can pursue internship / industrial projects on a full time basis.

24.3 One credit courses

One Credit Courses: Students can also opt for one credit industry oriented courses for a minimum of 15 hours duration, which will be offered by experts from industry on specialized topics apart from the prescribed courses of study of the programme. Students can complete such one credit courses during the semesters 5 to 7 as and when these courses are offered by any of the departments. There is no limit on the number of one credit courses a student can register and successfully complete during the above period.

Steps involved in designing and assessment of one credit courses:

Step1: The HOD and industry expert shall decide name and syllabi of the one credit course.

Step2: The concerned HOD collects the name list of the students those are interested in attending the above course. Each batch consists of 10 to 30 students.

Step3: The course shall be taught by industry experts as a course teacher.

Step4: The course teacher shall give assignments and conduct internal test 1&2 and viva voce.

Step5: The Course end examination shall be conducted and the evaluation will be done by the same industry expert.

EVALUATION PROCEDURE FOR ONE CREDIT COURSES

Total 50 Marks

Only one course end examination (for one and a half hours)	50 Marks
Proposed frame work for question paper and marks distribution	

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Objective type questions (20 x 1 mark)	20 Marks
Application oriented questions (3 x 10 marks)	30 marks
Total	50 marks

The exam is to be conducted at the end of the course. Passing criteria is 50% (that is, 25 marks out of 50 marks). If the student passes the course, it will be indicated in the grade sheet. If the student fails to pass the course, the one credit course will not get reflected in the grade sheet. There is no arrear exam for one credit courses. The one credit courses will not be considered for computing CGPA.

25. Human excellence courses

Four human excellence courses (with one credit for each of the courses – minimum 15 hours duration) will be offered from the first to forth semesters (one course per semester). Credits will be indicated for these courses in the grade sheet and will be considered for computing CGPA.

EVALUATION PROCEDURE FOR HUMAN EXCELLENCE COURSES

Total 50 Marks

Only one course end examination (for one and a half hours)	50 Marks
Proposed frame work for question paper and marks distribution	
Objective type questions (20 x 1 mark)	20 Marks
Application oriented questions (3 x 10 marks)	30 marks
Total	50 marks

The exam is to be conducted at the end of the course. Passing criteria is 50% (that is, 25 marks out of 50 marks). If the student passes the course, it will be indicated in the grade sheet. There will be arrear exam for human excellence courses.

26. Revision of Regulation and Curriculum

The institution may from time to time revise, amend or change the Regulations, scheme of examinations and syllabi, if found necessary. Academic Council assisted by Board of Studies

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and Standing Committee will make such revisions / changes.

Note: Any ambiguity in interpretation of this regulation is to be put up to the Standing Committee, whose decision will be final.

* * * * *

Note: - Printed during the year July – 2014.

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B.E. MECHATRONICS ENGINEERING

VISION

To achieve academic and industrial excellence in industrial automation research and innovative product development driven by Mechatronics systems.

MISSION

"The Department is committed to impart the right blend of knowledge and apply the knowledge in real life situations with constant engagement in research to cater the local and global needs.

PROGRAM EDUCATIONAL OBJECTIVES (PEO):

- Develop innovative and sustainable products with multidisciplinary Engineering expertise.
- Solve complex engineering problems by applying mechanical, electrical and .computer knowledge and engage in life long learning in their profession
- Work or pursue higher education in multicultural, multilingual and multinational environment with competent oral and written communication.
- Lead and contribute in a team entrusted with professional, social and ethical responsibilities.

PROGRAM OUTCOMES (PO):

PO1: Will be able to apply the laws of science and mathematics to provide engineering solutions to solve complex problems.

PO2: Will be able to identify and analyze complex problems by modeling with the help of literature survey and validate the solution with experiments.

PO3: Will be able to design and develop Mechatronics systems by selecting and integrating, sensors, appropriate materials, mechanics, thermal systems, manufacturing and automation methods.

PO4: Will be able to collect, condition monitor and interpret data to provide engineering solutions.

PO5: Will be able to create applications, products as well as modernizing the existing systems by using latest tools and technologies.

PO6: Will be able to develop solutions for local and global requirements by applying engineering knowledge and professional ethics.

PO7: Will have professional values on environmental and energy consumption for sustainability.

PO8: Will be able to become a leader and contribute in a team with entrepreneurial qualities.

PO9: Will be able to interact effectively in both oral and written format.

PO10: Will continuously update their knowledge and skills to meet the ever changing global needs.

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KUMARAGURU COLLEGE OF TECHNOLOGY, COIMBATORE 641 049
(An Autonomous Institution to Anna University, Chennai)

REGULATIONS 2014

B.E. MECHATRONICS ENGINEERING

CURRICULUM AND SYLLABI

SEMESTER – III

Code No.	Course Title	L	T	P	C
THEORY					
U14MAT 313	Transform methods and Partial Differential Equations	3	0	1	4
U14MC*T* 301	Sensors and Instrumentation	3	0	0	3
U14MC*T* 302	Kinematics of Machinery	3	1	0	4
U14MC*T* 303	Electrical Machines and Drives	3	0	0	3
U14MC*T* 304	Mechanics of Fluids for Mechatronics	3	1	0	4
U14GS*T* 001	Environmental Science and Engineering	3	0	0	3
PRACTICAL					
U14MC*P* 301	Fluid Mechanics and Machinery Laboratory	0	0	2	1
U14MC*P* 302	Sensors and Instrumentation Laboratory and Projects	0	0	2	1
U14MC*P* 303	Electrical Machines Laboratory	0	0	2	1
U14GH*P* 301	Social Values	1	0	1	1

Total credits – 25

SEMESTER – IV

Code No.	Course Title	L	T	P	C
THEORY					
U14MA*T* 401	Numerical Methods	3	1	0	4
U14MC*T* 401	Manufacturing Technology	3	0	0	3
U14MC*T* 402	Industrial Electronics	3	0	0	3
U14 MC*T* 403	Mechanics of Solids for Mechatronics	3	1	0	4
U14 MC*T* 404	Dynamics of Machinery	3	1	0	4
U14MC*T* 405	Digital Electronics and Microprocessor	3	0	0	3
PRACTICAL					
U14ME*P* 404	Machine Dynamics Laboratory	0	0	2	1
U14MC*P* 401	Industrial Electronics Laboratory and Projects	0	0	2	1
U14MC*P* 402	Manufacturing Technology Laboratory	0	0	2	1
U14GH*P* 401	National and Global Values	1	0	1	1

Total credits - 25

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SEMESTER – V

Code No.	Course Title	L	T	P	C
THEORY					
U14MC*T* 501	Signals and Systems	3	1	0	4
U14MC*T* 502	Microcontroller and Embedded Systems	3	0	0	3
U14MC*T* 503	Control Engineering	3	1	0	4
U14MC*T* 504	Mechatronics for Machining	3	0	0	3
U14MC*T* 505	Maintenance Engineering	3	0	0	3
U14MC*T* 506	Industrial Automation I	3	0	0	3
PRACTICAL					
U14MC*P* 501	Industrial Automation I Laboratory and Projects	0	0	2	1
U14MC*P* 502	CAD/CAM Laboratory and Projects	0	0	2	1
U14MC*P* 503	Microprocessor and Microcontroller Laboratory	0	0	2	1

Total credits - 23

SEMESTER–VI

Code No.	Course Title	L	T	P	C
THEORY					
U14MC*T* 601	Functional programming	2	0	1	3
U14MC*T* 602	Design of Machine Elements	3	1	0	4
U14MC*T* 603	Robotics Engineering	3	0	0	3
U14ME*T* 604	Thermodynamics and Heat Transfer	3	1	0	4
E1	Elective I	3	0	0	3
E2	Elective–II	3	0	0	3
PRACTICAL					
U14MCP 601	Mini Project	0	0	4	2
U14MC*P* 602	Robotics Laboratory	0	0	2	1
U14EN*P* 601	Communication Skill Laboratory	0	0	2	1

Total credits - 24

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SEMESTER–VII

Code No.	Course Title	L	T	P	C
THEORY					
U14MCT 701	Industrial Automation II	3	0	0	3
U14MC*T* 702	Automotive Electronics	3	0	0	3
U14MC*T* 703	Micro Electro Mechanical Systems	3	0	0	3
U14GS*T* 007	Professional Ethics	3	0	0	3
E3	Elective–III	3	0	0	3
E4	Elective–IV	3	0	0	3
PRACTICAL					
U14MC*P* 701	Industrial Automation II Laboratory and Projects	0	0	2	1
U14MC*P* 702	Embedded system Design Laboratory	0	0	2	1
U14MC*P* 703	Project Work Phase I	0	0	4	2

Total credits - 22

SEMESTER–VIII

Code No.	Course Title	L	T	P	C
THEORY					
E5	Elective–V	3	0	0	3
E6	Elective–VI	3	0	0	3
E7	Elective–VII	3	0	0	3
PRACTICAL					
U14MCP801	Project Work Phase II	0	0	18	9

Total credits – 18

Total Credits (3rd to 8th Semesters) =138

Overall Total Credits (1st to 8th Semesters) - 185

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LIST OF ELECTIVES

ELECTIVE I

Code No	Course Title	L	T	P	C
U14MCE 101	Engineering Economics & Management	3	0	0	3
U14GST 005	Total quality Management	3	0	0	3
U14MCE 102	Foundation Skills in Integrated Product Development	3	0	0	3

ELECTIVE II

U14MCE201	Computer Integrated Manufacturing	3	0	0	3
U14MCE202	Engineering Metrology	3	0	0	3
U14MCE203	Machine Vision Systems	3	0	0	3
ELECTIVE III					
U14MCE301	Modeling and Simulation	3	0	0	3
U14MCE302	Statistical Quality Control	3	0	0	3
U14GST 006	Probability and Applied Statistics	3	0	0	3
ELECTIVE IV					
U14MCE 401	Finite Element Analysis	3	0	0	3
U14MCE 402	Geometric Dimensioning and Tolerances	3	0	0	3
U14MCE 403	Design of Material Handling System	3	0	0	3
ELECTIVE V					
U14MCE 501	Artificial Intelligence	3	0	0	3
U14MCE 502	Textile Mechatronics	3	0	0	3
U14MCE 503	Medical Mechatronics	3	0	0	3
U14MCE 504	Soft Computing	3	0	0	3
ELECTIVE VI					
U14MCE 601	Renewable Energy Sources	3	0	0	3
U14MCE 602	Energy Conversion Systems	3	0	0	3
U14MCE 603	Energy Management and Auditing	3	0	0	3
ELECTIVE VII					
U14MCE 701	Intellectual Property Rights (IPR)	3	0	0	3
U14MCE 702	Composite Materials Sustainable Development	3	0	0	3
U14MCE 703	Digital Signal Processing	3	0	0	3
ONE CREDIT COURSES					
U14MCIN01	Certification Program				

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U14MAT313	TRANSFORM METHODS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		3	0	1	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Explain the concepts of Fourier series and the transform of periodic functions.
CO2: Derive the Fourier transform of Non periodic functions.
CO3: Identify the classification of PDE and its solutions
CO4: Solution of the PDE by Laplace transform and Fourier transform methods
CO5: Solution of boundary value problems by MATLAB

Pre-requisite

1. U14MAT101 Engineering Mathematics -I
2. U14MAT201 Engineering Mathematics - II

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	P10
CO1	S									
CO2	S									
CO3		S				M				
CO4				M		S				
CO5				S	S	S				

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

FOURIER SERIES **12Hours**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's identity – Harmonic Analysis

FOURIER TRANSFORM **12Hours**

Infinite Fourier transform pair – Infinite Sine and Cosine transforms – Properties – Transforms

FOURIER TRANSFORM **12Hours**

Infinite Fourier transform pair – Infinite Sine and Cosine transforms – Properties –

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Transforms of simple functions – Convolution theorem – Parseval's identity

PARTIAL DIFFERENTIAL EQUATIONS 12Hours

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Solution of standard types of first order partial differential equations (excluding reducible to standard types) – Lagrange's linear equation – Linear Homogeneous partial differential equations of second and higher order with constant coefficient

SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS 12Hours

Laplace Transform Method: Solution of PDE's: solution of diffusion equation. Fourier Transform Method: Solution of PDE's: solution of diffusion equation and Laplace equation-simple problems.

SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS – USING MATLAB 12Hours

PDE in One Space Dimension : Single equations - Single Equations with Variable Coefficients - Single PDE in Two Space Dimensions: Elliptic PDE - Parabolic PDE

Theory: 45Hr Practical: 15 Hr Total Hours: 60

REFERENCES

1. K. Sankara Rao, "Introduction to partial differential equations", Prentice Hall of India, New Delhi (2006).
2. Veerarajan T., "Engineering Mathematics" (for semester III), Third Edition, Tata McGraw Hill, New Delhi (2007).
3. Grewal, B.S., "Higher Engineering Mathematics", Thirty Sixth Edition, Khanna Publishers, Delhi, 2001.
4. Ian Sneddon. , "Elements of partial differential equations", McGraw – Hill New Delhi, 2003.
5. Howard B.Wilson and Louis H. Turcotte, "Advanced Mathematics and Mechanics Applications Using Matlab", - McGraw – Hill, 1998.

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U14MCT301 SENSORS AND INSTRUMENTATION

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

- **CO1:** Classify the transducers and instruments based on their working principles, characteristics and order of the system.
- **CO2:** Use statistical methods to compute the errors in the measurements and calculate the response of zero, 1st and second order measurement systems.
- **CO3:** Describe the working principle and characteristics of non electrical transducers Such as displacement, velocity, temperature, pressure, humidity, force and light.
- **CO4:** Describe the working principle, characteristics of non electrical transducers such as force (resistive, fiber optic and piezo), vacuum, airflow and light.
- **CO5:** Explain and differentiate various acoustic parameters and systems with their measurement transducer.
- **CO6:** Discuss about the construction, working principles and characteristics of electrical parameter measurement systems and able to apply for CT and PT principles to extend the measurement range.
- **CO7:** Choose appropriate transducer and a signal conditioning circuit for a given mechatronics application.
- **CO8:** Explain the principles of various elements used in signal conditioning, conversion, acquisition and transmission. Also able to design simple circuits related signal conditioning and conversion.

Pre-requisite

1 U14MCT201 Electronic Devices and Circuits

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S		M							
CO2	S	S	S		M					W
CO3	S		M							
CO4	S		M							
CO5			S	S	M					M
CO6			M		W					
CO7		S	S		S				M	M
CO8			S		S	S			S	S

Course Assessment methods:	
Direct	**Indirect**

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Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

MEASUREMENT SYSTEMS **9Hours**

Generalized Measurement System – Performance Characteristics: Static and Dynamic Characteristics – Errors in Measurements – Calibration and Standards – Generalized Performance of Zero Order, First Order and Second Order Systems – Classifications of Transducers- General working principles of Resistive, capacitive and inductive type transducers with governing equations.

MEASUREMENT OF NON ELECTRICAL PARAMETERS-1 **9Hours**

Linear and angular displacement: Resistive, capacitive, inductive types and Optics (encoders), proximity sensors

Velocity measurement: tachometers, tachogenerators and resolvers

Temperature measurement: Contact type: Bimetallic, RTD, Thermocouple and Thermistor

Non- Contact type: Radiation Pyrometer – Optical Pyrometer

Humidity: Capacitive and resistive and hot and wet bulbs.

Other sensors: Fire, smoke and metal detectors.

MEASUREMENT OF NON ELECTRICAL PARAMETERS-2 **9Hours**

Force measurement: Resistive type strain gauges: Bridge configurations, Temperature compensation, Load cells, Fiber optic strain gauge- Semiconductor strain gauges- Piezo electric transducers.

Vacuum Measurement: McLeod Gauge, Thermal Conductivity Gauge – Ionization Gauge.

Airflow: Anemometers

Light: UV, IR, Light emitter and detector

Introduction to Acoustics and acoustic sensors: Ultrasonic sensor- Types and working of Microphones and Hydrophones – Sound level meters- Nuclear radiation sensors.

MEASUREMENT OF ELECTRICAL PARAMETERS **9Hours**

3 phase &1phase 1 watt meter and power factor - Resistive, capacitive and inductive measurements- Instrument Transformers: CT and PT; their errors, Applications of CT and PT in the extension of instrument range.

SIGNAL CONDITIONING AND DATA ACQUISITION **9Hours**

Amplification, Filtering – Level conversion – Linearization - Buffering – Sample and Hold circuit – Quantization – Multiplexer / Demultiplexer – Analog to Digital converter – Digital to Analog converter- I/P and P/I converter - Instrumentation Amplifier-V/F and F/V converter- Data Acquisition -Data Logging – Data conversion – Introduction to Digital Transmission system.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Ernest O. Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009.
2. D. Patranabis, “Sensors and Transducers”, PHI, New Delhi, 2nd Edition, 2010.

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3. John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science Publications, 1999
4. A.K. Sawney and Puneet Sawney, “A Course in Mechanical Measurements and Instrumentation and Control”, 12th edition, Dhanpat Rai & Co, New Delhi, 2013.

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U14MCT302 KINEMATICS OF MACHINERY

L	T	P	C
3	1	0	4

Course Outcomes

After successful completion of this course, the students should be able to

- **CO1:** Classify and choose appropriate mechanisms by describing their relative motion and type of contact
- **CO2:** Calculate the position, velocity, acceleration of multi-bar mechanisms by applying vector mechanics and graphical methods
- **CO3:** Construct different types of cam profile for a given application using graphical method.
- **CO4:** Choose appropriate mechanism for a given power transfer and/or transforming application.
- **CO5:** Solve problems on power transmission and power loss due to friction in various machine elements.

Pre-requisite

1. U14MET101 Engineering Graphics
2. U14MET201 Engineering Mechanics

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	W		M	M						
CO2	M	M	M	M					M	
CO3			M		M				M	
CO4			M		W					
CO5	M	M	M	M	M					

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

BASICS OF MECHANISMS **12Hours**

Terminology and Definitions - Degree of Freedom Mobility - Kutzbach criterion - Grashoff's law-Kinematic Inversions of 4-bar chain and slider crank chains - Mechanical Advantage - Transmission angle - Description of common Mechanisms - Single, double and offset slider mechanisms - Quick return mechanisms – Ratchets and escapements - Indexing

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Mechanisms - Rocking Mechanisms - Design of Crank - rocker Mechanisms.

KINEMATICS 12Hours

Displacement, velocity and acceleration analysis in simple mechanisms - Construction of velocity and acceleration polygons using graphical mehod - Velocity analysis: Instantaneous centre method- Acceleration analysis: Klein's construction - Coriolis Acceleration. **Tutorial:** Simulation and kinematic analysis of simple mechanisms using mathematical and drafting softwares.

KINEMATICS OF CAM 12Hours

Classifications - Displacement diagrams – Modified uniform velocity, Parabolic, Simple harmonic and Cycloidal motions - Layout of plate cam profiles - Derivatives of Follower motion – circular arc and tangent cams - Standard cam motion – Significance of Pressure angle and undercutting - Limitations of graphical methods Analysis of motion of followers: Roller follower – circular cam - **Tutorial:** Design of high speed cams using spreadsheets.

GEARS AND GEAR TRAINS 12Hours

Spur gear Terminology and definitions-Fundamental Law of toothed gearing and involute gearing - Inter changeable gears - gear tooth action - Terminology - Interference and undercutting - Non standard gear teeth- Helical, Bevel, Worm, Rack and Pinion gears (Basics only) - Gear trains - Parallel axis gear trains -Epicyclic gear trains - Differentials.

FRICTION 12Hours

Surface contacts-Sliding and Rolling friction - Friction drives - Friction in screw threads - Friction clutches: cone and plate clutches - Belt and rope drives, Friction aspects in Brakes.

CASE STUDY: Application of kinematics in the field of sports, forward and inverse kinematics in robotics.

SELF STUDY: Steering mechanisms: Davis and Ackermann Steering gear.

Theory: 45Hr **Tutorial: 15 Hr** **Total Hours: 60**

REFERENCES

1. Rattan S.S, "Theory of Machines'', Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2009.
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U14MC*T* 303 ELECTRICAL MACHINES AND DRIVES

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

- **CO1:** Get the basic knowledge about the Electric and Magnetic circuits.
- **CO2:** Construct, state the principle of operation and performance of DC motors.
- **CO3:** Construct, state the principle of operation and performance of Induction machines.
- **CO4:** Construct, state the principle of operation and performance of special machines
- **CO5:** Construct, state the principle of operation and performance of linear electrical machines.

Pre-requisite

U14MCT201 Electronic Devices and Circuits

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	S								W
CO2	W	M	M		S	M	S			
CO3	W	M	M		S	M	S			
CO4	W	M	M		S	M	S			
CO5	W	M	M		S	M	S			

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

BASIC OF ELECTRICAL MACHINES **9Hours**

Magnetic Circuits – Magnetic Material and Their Property – Magnetically Induced EMF and Force – AC Operation of Magnetic Circuits – Hysteresis and Eddy current Losses – Permanent Magnets – Application of permanent Magnet Materials – Energy in magnetic System – field energy and mechanical force – multiply excited magnetic field systems – force / torques system with permanent magnets – energy conversion via electric field – Elementary machines – generated EMF – MMF of distributed AC windings – rotating magnetic field – torque in round rotor machine – operation of basic machine types – linear machines

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DC MACHINES **9Hours**

Introduction – Armature winding and commutator – EMF and Torque – Methods of Excitation – Self Excitation – Speed control of DC motors.

AC MACHINES **9Hours**

Induction Machine – Introduction – construction – flux and MMF waves in IM – Starting – cogging – crawling – speed control of IM.

SPECIAL MACHINES **9Hours**

Stepper Motor - Construction – working - Switched Reluctance Motor (SRM) - Construction – working -Permanent Magnet DC (PMDC) Motor - Construction – working - Brushless Permanent Magnet DC (BLDC) Motors - Construction – working - Permanent Magnet Synchronous Motor (PMSM) Construction – working-Servo Motor - Construction – working.

LINEAR ELECTRICAL MACHINES **9Hours**

Linear Induction Motor (LIM) - Construction – Trust Equation of LIM – Eq. CKT of LIM – Characteristics of LIM – Control of LIM – Linear Synchronous Motor (LSM) – Types and Construction – Trust Equation – Control of LSM

CASE STUDY: Section of suitable application of each and every motor considering the selection process.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. E. G. Janardanan, "Special Electrical Machines" PHI Learning Private Limited, Delhi, 2014.
2. Nagrath, I.J., and Kothari, D.P., "Electrical Machines", Tata McGraw-Hill, New Delhi, 3rd Edition, 2006.
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5. Partab, H., "Art and Science and Utilization of electrical energy", Dhanpat Rai and Sons, New Delhi, 1994.

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U14MCT304

MECHANICS OF FLUID FOR MECHATRONICS

L	T	P	C
3	1	0	4

Course Outcomes

After successful completion of this course, the students should be able to

- **CO1:** Describe the properties of fluids and its importance in selection of fluid for suitable application.
- **CO2:** Apply the concept of fluid statics to determine the pressure and forces on plane and curved surfaces.
- **CO3:** Differentiate the types of flow with its characteristics and also calculate the flow rate by applying concept of fluid kinematics and dynamics.
- **CO4:** Identify the major and minor losses involved in the fluid flow through pipes.
- **CO5:** Generate set of dimensionless parameters in fluid flow problems and also perform dimensional analysis on them.
- **CO6:** Define and classify the different types of hydraulic machines and select them based on performance for real time applications.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	M									
CO2	S	M								S
CO3	S									
CO4	S									
CO5	S	M								S
CO6	S	S								S

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

FLUID PROPERTIES AND FLUID STATICS 9Hours

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Fluid - definition, distinction between solid and fluid - Units and dimensions – Properties of fluids - density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapor pressure, capillary and surface tension.
Fluid statics: Pascal law - Hydrostatic law - Relative equilibrium - Pressure measurements using Manometers and pressure gauges - Forces on immersed plane and curved surfaces – Buoyancy – Meta-centre - Stability of floating and submerged bodies.

FLIUD KINEMATICS AND FLUID DYNAMICS 15Hours

Fluid Kinematics – Lagrangian and Eulerian descriptions - Flow visualization - Lines of flow - Types of flow - Flow characteristics – concept of control volume - velocity field and acceleration -continuity equation – energy equation – momentum equation – Impact of jets - Equation of streamline - stream function - velocity potential function - circulation – flow net.
Fluid dynamics - equations of motion - Euler's equation along streamline - Bernoulli's equation – Applications - Venturi meter, Orifice meter, Pitot tube.

FLUID FLOW AND DIMENSIONAL ANALYSIS 15Hours

Laminar flow between parallel plates - Laminar flow through circular tubes (Hagen Poiseuille equation) - Turbulent Flow in a pipe – Boundary layer concepts – types of boundary layer thickness - Hydraulic and energy gradient - Darcy Weisbach equation - Pipe roughness - Friction factor - Moody's diagram minor losses - Flow through pipes in series and in parallel.
Dimension and units - Buckingham π theorem - Discussions on dimensionless parameters – applications - Laws of models and similitude.

HYDRAULIC TURBINES 11Hours

Fluid machines: definition and classification - exchange of energy - Euler's equation for turbo machines - Construction of velocity vector diagram's - head and specific work - components of energy transfer - degree of reaction.
Hydro turbines: definition and classifications - Pelton turbine - Francis turbine – propeller turbine - Kaplan turbine - working principles - velocity triangles - work done – specific speed - efficiencies -performance curve for turbines.

HYDRAULIC PUMPS 10Hours

Pumps: definition and classifications - Centrifugal pump: classifications, working principles, velocity triangles, specific speed, efficiency and performance curves - Reciprocating pump: classification, working principles, indicator diagram, and work saved by air vessels and performance curves - Cavitations in pumps.

Theory: 45Hr Tutorial: 15 Hr Total Hours: 60

REFERENCES

1. White, F.M., "Fluid Mechanics", Tata McGraw-Hill, 7th Edition, New Delhi, 2011.
2. Douglas J.F., Gasoriek J.M., (et.al), "Fluid Mechanics", Pearson India, 5th Edition, 2008.
3. Cengel Y.A., Cimbala J.M., " Fluid Mechanics – Fundamentals and applications", McGraw Hill higher education, 2nd Edition, 2010.
4. Modi P.N., Seth S.M., "Hydraulics and fluid mechanics including hydraulic machines" Standard publishers, 20th edition, 2015
5. Bansal, R.K., "Fluid Mechanics and Hydraulics Machines", (9th edition), Laxmi publications (P) Ltd., New Delhi, 2011.
6. Som, S.K., and Biswas, G., "Introduction to fluid mechanics and fluid machines", Tata McGraw-Hill, 2nd edition, 2007.
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U14GS*T*001 **ENVIRONMENTAL SCIENCE AND ENGINEERING**

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

- **CO1:** Explain the Natural resources and the problems related to natural resources.
- **CO2:** Describe the Eco systems , bio diversity and their significance on livelihood
- **CO3:** Explain various pollutions and their impact on environment and livelihood.
- **CO4:** Describe the legislation related to pollution
- **CO5:** Describe the effect of human population and their impact on environment

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S					S	S			
CO2	S					S	S			
CO3	S					S	S			
CO4	S					S				
CO5	S					S	S			

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES 10Hours

Definition, scope and importance – Need for public awareness – Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of

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alternate energy sources. Case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – Role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles

ECOSYSTEMS AND BIODIVERSITY **14Hours**

Concept of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity – Biogeographical classification of India – Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

ENVIRONMENTAL POLLUTION **8Hours**

Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – Solid waste Management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

SOCIAL ISSUES AND THE ENVIRONMENT **7Hours**

From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns, case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – Wasteland reclamation – Consumerism and waste products – Environment Production Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness

HUMAN POPULATION AND THE ENVIRONMENT **6Hours**

Population growth, variation among nations – Population explosion – Family Welfare Programme – Environment and human health – Human Rights – Value Education – HIV / AIDS – Women and Child Welfare – Role of Information Technology in Environment and human health – Case studies. .

FIELD WORK

Visit to local area to document environmental assets- river / grassland / hill / mountain, visit to local polluted site- urban / rural / industrial / agricultural, study of common plants, insects, birds, study of simple ecosystems-pond, river, hill slopes etc.,

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Deswal.S and Deswal.A, "A basic course in Environmental studies" DhanpatRai& Co,

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2. Gilbert M.Masters, Introduction to Environmental Engineering and Science, Pearson Education Pvt., Ltd., Second Edition, ISBN 81-297-0277-0, 2004.
3. Miller T.G. Jr., Environmental Science – Sustaining the earth, Wadsworth Publishing Co., 1993.
4. BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad India, 2002.
5. Trivedi R.K., Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro Media. 1996.
6. Cunningham, W.P.Cooper, T.H.Gorhani, Environmental Encyclopedia, Jaico Publ., House, Mumbai, 2001.
7. Wager K.D., Environmental Management, W.B. Saunders Co., Philadelphia, USA, 1998.
8. Townsend C., Harper J and Michael Begon, "Essentials of Ecology", Blackwell science Publishing Co., 2003.
9. Trivedi R.K and P.K.Goel, "Introduction to Air pollution" Techno-science Pubications. 2003.
10. Yamuna R.T, "Environmental Science" Inter Publications, 2008

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U14MC*P* 301 **FLUID MECHANICS AND MACHINERY LABORATORY**

L	T	P	C
0	0	2	1

Course Outcomes

After successful completion of this course, the students should be able to

- **CO1:** Determine the viscosity of fluids and its importance in selection of fluids
- **CO2:** Identify the different pressure measurements and able to determine the pressure in a fluid at rest and in motion.
- **CO3:** Determine the flow rate and Co-efficient of discharge for given Orificemeter and Venturimeter.
- **CO4:** Calculate the friction factor of pipes made up of various materials.
- **CO5:** Compare the performance characteristics of various hydraulic turbines.
- **CO6:** Test the performance of various positive and non-positive displacement pumps.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	S		S				S	M	
CO2	S			S				S	M	
CO3	S			S				S		
CO4	S			S				S		
CO5	S			S				S		
CO6	S			S				S		

Course Assessment methods:	
Direct	**Indirect**
Lab Exercises Model Exam. End Semester Practical Examination Assignment	Course end survey

LIST OF EXPERIMENTS

1. Measurement of viscosity of a given liquid.
2. Measurement of Atmospheric, Absolute and Gauge Pressures.
3. Pressure Measurements using U-tube differential manometers, Bellows Pressure gauge, Bourdon tube Pressure gauge and Diaphragm Pressure gauge.
4. Determination of the Coefficient of discharge of given
    a. Orificemeter,

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   b. Venturimeter
5. Flow rate measurement through Orifice by
   a. Constant Head Method
   b. Variable Head Method
6. Calculation of the rate of flow using Roto meter.
7. Determination of friction factor of given set of pipes.
8. Conducting experiments and drawing the characteristic curves of centrifugal pump / submersible pump
9. Conducting experiments and drawing the characteristic curves of reciprocating Pump.
10. Conducting experiments and drawing the characteristic curves of Gear pump.
11. Conducting experiments and drawing the characteristic curves of Pelton wheel.
12. Conducting experiments and drawing the characteristics curves of Francis turbine.
13. Conducting experiments and drawing the characteristic curves of Kaplan turbine.

Experiments beyond the syllabus should be conducted

Total Hours: 45

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U14MCP 302 **SENSORS AND INSTRUMENTATION LABORATORY AND PROJECTS**

L	T	P	C
0	0	2	1

Course Outcomes

After successful completion of this course, the students should be able to

- **CO1:** Generate appropriate design procedure, suitable for signal conversion to interface with computer.
- **CO2:** Design appropriate circuits by using conventional formulas used in signal conditioning and conversion.
- **CO3:** Implement their design in bread board and test it.
- **CO4:** Generate appropriate design procedure to obtain a required measurement data for temperature, force, humidity, displacement and sound.
- **CO5:** Log the data in computer using LABVIEW/ MATLAB/PSILAB.
- **CO6:** Present data in a clear and meaningful manner.
- **CO7:** Use transducers to create simple Mechatronics applications using data logging software.

Pre-requisite

U14MCT301 Sensors and Instrumentation

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S		W							
CO2	S		S							
CO3						S				S
CO4	S	W	M			W				
CO5				S					M	S
CO6				S					M	
CO7					S	S				M

Course Assessment methods:	
Direct	**Indirect**
Lab Exercises Model Exam. End Semester Practical Examination Assignment	Course end survey

LIST OF EXPERIMENTS

1. Design and testing of Digital Comparator
2. Design and testing of Voltage to frequency converter and frequency to voltage converter.

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3. Design and testing of sample and hold circuit.
4. Design and testing of Flash type Analog to Digital Converters.
5. Design and testing of instrumentation amplifier using OP-AMP.
6. Displacement measurement using potentiometer and LVDT and plotting the characteristic curves.
7. Study of Characteristics and calibration of strain gauge and Load Cell
   a. Measurement of strain using resistive type strain gauges with temperature compensation and various bridge configurations.
8. Temperature measurement using Thermocouple, Thermistor and RTD and comparing the characteristics.
9. Comparison of capacitive and resistive type transducer for humidity measurement with their characteristics.
10. Measurement of sound using microphones and sound level meter.

ADDITIONAL EXPERIMENTS

11. Conversation of time domain audio signal into frequency domain signal (FFT).
12. Measurements of 3 phase power and power factor.

NOTE: Experiments 6- 9 should be logged in computer by using data acquisition system and LABVIEW/MATLAB/PSILAB.

Experiments beyond the syllabus should be conducted

Total Hours: 45

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U14MCP 303

ELECTRICAL MACHINES LABORATORY

L	T	P	C
0	0	2	1

Course Outcomes

After successful completion of this course, the students should be able to

- **CO1:** Test and assess the performances of the DC motors and single phase AC motor for varying load.
- **CO2:** Control the speed of AC and DC motor.
- **CO3:** Analyze and present the findings of experimental observations in both written and oral format.

Pre-requisite

1. U14MCT303 Electrical Machines and Drives

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	M	W							M
CO2	S	M	W							M
CO3									S	M

Course Assessment methods:	
Direct	**Indirect**
Lab Exercises Model Exam. End Semester Practical Examination Assignment	Course end survey

LIST OF EXPERIMENTS

1. Load test on DC Shunt motor
2. Load test on DC series motors
3. Speed control of DC shunt motor (Armature and Field Control)
4. Load Test on Three Phase Squirrel Cage Induction motor
5. Load Test on Single phase induction motor
6. Speed control of three phase slip ring induction motor
7. Speed control of DC shunt motor using controlled rectifiers
8. Speed control of BLDC motor.
9. Speed control of Stepper motor.
10. Voltage / Frequency control of three phase induction motor using inverter.
11. Study of DC & AC starters

Experiments beyond the syllabus should be conducted

Total Hours: 45

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U14GHP301

SOCIAL VALUES
(Common to all branches of Engineering and Technology)

L	T	P	C
1	0	1	1

Course Outcomes

After successful completion of this course, the students should be able to

- **CO1:** Adopt and practice social values as his regular duties.
- **CO2:** Take over the social responsibilities.
- **CO3:** Give solutions and to manage the challenging social issues.
- **CO4:** Voluntarily participate and organize social welfare programmes.
- **CO5:** Explore his ideology of techno social issues and provide the best solution.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1						W	W		M	S
CO2						S			M	
CO3						M	W			
CO4						W		S	M	W
CO5						W	M			W

Course Assessment methods:	
Direct	**Indirect**
Continuous Assessment End Semester Examination	Course end survey Attitude Behavior

ORGIN OF SOCIETY **5 Hours**

Evolution of universe: Creation theory, Big bang theory, Evolution theory, Permanence theory - Mithya, Maya – Evolution of living being - Evolution of Man – Formation of society and social values.

Practical: Group Discussion on Evolution of Man and formation of society, Panel discussion on Social values - Pancha Bhoodha Navagraha Meditation.

SELF AND SOCIETY **2 Hours**

Duty to self, family, society and world –Realization of Duties and Responsibilities of individuals in the society (Five fold cultures) – impact of social media on present day youth and correction measures.

Practical: Case study – interaction with different professionals.

EDUCATION& SOCIETY **3 Hours**

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Education: Ancient and Modern Models.

Practical: Making Short film on impact of education in social transformation

DISPARITY AMONG HUMAN BEINGS **3 Hours**

Wealth's for humans, Factors leading to disparity in human beings and Remedies.

Practical: Debate on disparity and social values

CONTRIBUTION OF SELF TO SOCIAL WELFARE **3 Hours**

Participation in Social welfare – Related programmes– Recognized association – Activities for social awareness – Programme by Government and NGOs – Benefits of social service – Balancing the family and social life.

Practical: In campus, off campus projects

GENERAL PRACTICAL **14 Hours**

Ashtanga Yoga: Pathanjali maharishi & Yoga – Involvement – Rules of Asanas -

Suryanamaskara (12 Steps) - Meditation.

Standing: Pada Hastasana, Ardha Cakrasana, Trikonasana, Virukchsana (Eka Padaasana)

Sitting : Padmasana, Vakrasana, Ustrasana, Paschimatanasana.

Prone : Uthanapathasana, Sarvangasana, Halasana, Cakrasana,

Supine : Salabhasana, Bhujangasana, Dhanurasana, Navukasana.

Theory: 16 Hrs **Practical: 14 Hrs** **Total Hours: 30**

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1. Steven, Weinberg, "The First Three Minutes", A Modern View of the Origin of the Universe (English), Perseus books group, 1977.
2. Vethathiri's Maharishi's, "Vethathirian Principles of Life", The World Community Service Centre, Vethathiri Publications, 2003
3. Vethathiri's Maharishi's, "Karma Yoga: The Holistic Unity", The World Community Service Centre, Vethathiri Publications, 1994.
4. Vethathiri's Maharishi's, "Prosperity of India", The World Community Service Centre, Vethathiri Publications, 1983.
5. Swami Vivekananda, "The Cultural Heritage of India", First Edition, Ramakirshna Mission Institute of Culture, 1937.
6. Vivekananda Kendra Prakashan Trust, "YOGA", Vivekanandha Kendra Prakashan Trust, Chennai, 1977.

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SEMESTER IV

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U14MA*T*401 **NUMERICAL METHODS**

L	T	P	C
3	1	0	4

Course Outcomes

After successful completion of this course, the students should be able to

- **CO1:** Solve a set of algebraic equations representing steady state models formed in engineering problems.
- **CO2:** Fit smooth curves for the discrete data connected to each other or to use interpolation methods over these data tables.
- **CO3:** Find the trend information from discrete data set through numerical differentiation and summarize information through numerical integration.
- **CO4:** Predict the system dynamic behavior through solution of ODEs modeling the system.
- **CO5:** Solve PDE models representing spatial and temporal variations in physical systems through numerical methods.
- **CO6:** Use MATLAB for obtaining the above solutions.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	M	W							
CO2	S									
CO3	S									
CO4	S									
CO5	S									
CO6	S	W			S					

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION **8Hours**

Simple mathematical modeling and engineering problem solving – Algorithm Design – Flow charting and pseudo code - Accuracy and precision – round off errors

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NUMERICAL SOLUTION OF ALGEBRAIC EQUATIONS 8Hours

Solution of nonlinear equations - False position method – Fixed point iteration – Newton Raphson method for a single equation and a set of non- linear equations

Solution of linear system of equations by Gaussian elimination, Gauss Jordan method - Gauss Seidel method.

CURVE FITTING AND INTERPOLATION 8Hours

Curve fitting – Method of least squares - Newton's forward and backward difference formulas – Divided differences – Newton's divided difference formula - Lagrange's interpolation – Inverse interpolation.

NUMERICAL DIFFERENTIATION AND INTEGRATION 9Hours

Numerical differentiation by using Newton's forward, backward and divided differences – Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rules – Numerical double integration.

NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 12Hours

Initial value problems - Single step methods: Taylor's series method – Truncation error – Euler and Improved Euler methods – Fourth order Runge – Kutta method – Multistep methods: Milne's predictor - corrector method.

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (PDEs) 15Hours

Surface contacts-Sliding and Rolling friction - Friction drives - Friction in screw threads - Friction clutches: cone and plate clutches - Belt and rope drives, Friction aspects in Brakes.

Use of MATLAB Programs to workout solutions for all the problems of interest in the above topics.

Theory: 45Hr **Tutorial: 15 Hr** **Total Hours: 60**

REFERENCES

1. Steven C.Chapra and Raymond P. Canale, "Numerical Methods for Engineers with Programming and Software Applications", Sixth Edition, WCB/McGraw-Hill, 1998.
2. John H. Mathews and Kurtis D. Fink, "Numerical Methods using Matlab", Fourth Edition, Prentice Hall of India, 2004.
3. Gerald C. F. and Wheatley P.O, "Applied Numerical Analysis", Sixth Edition, Pearson Education Asia, New Delhi, 2002.
4. Sastry S.S, "Introductory Methods of Numerical Analysis", Third Edition, Prentice – Hall of India Pvt Ltd, New Delhi, 2003.
5. Kandasamy P., Thilagavathy K. and Gunavathy K., "Numerical Methods", S.Chand Co. Ltd., New Delhi, 2007.

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U14MC*T* 401 MANUFACTURING TECHNOLOGY

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

- **CO1:** Define and distinguish various manufacturing processes
- **CO2:** Select and justify appropriate casting methods
- **CO3:** Anticipate general casting defects and explain their remedies
- **CO4:** Summarize various bulk deformation processes and the explain the working machineries
- **CO5:** Describe the working principles of machines and various machining processes.
- **CO6:** Choose a suitable metal joining process for a given application.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S								S	
CO2	S					S	M			
CO3				S					S	
CO4	S								S	
CO5	S								S	
CO6		S				S				

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

FOUNDRY TECHNOLOGY 9Hours

Pattern and Core making – Moulding sand – Melting furnaces: Cupola and Induction furnaces – Special casting processes – Shell, Investment, Die casting – Defects in casting.

FORMING PROCESSES 9Hours

Hot and Cold Working Rolling - Introduction – Rolling Mills – Rolling Operations – Forging - Introduction – Related Forging Operations – Drop forging- Extrusion and Drawing - Extrusion Practice – Hot, Cold, Impact and Hydrostatic extrusion. Drawing Process – Defects and Residual Stresses – Drawing Equipment. Sheet metal operations – Blanking, Punching and

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Piercing. (Treatment is to be given only on operations)

CONVENTIONAL MACHINING PROCESS **9Hours**

Lathes and Lathe Operations, Drilling and Drilling Machines, Reaming and Reamers, Tapping and Taps – Tool nomenclature, cutting speed, feed, machining Time calculations. (No Treatment on mechanisms).

SPECIALIZED MACHINING AND SUPER FINISHING PROCESS **9Hours**

Milling Machines and Operations, Planning and Shaping, Broaching, Gear Hobbing and Shaping. Grinding Process – Abrasives – Finishing Operations – Lapping, Honing Burnishing. (No Treatment on mechanisms).

PRINCIPLES & APPLICATIONS OF JOINING PROCESSES **9Hours**

Gas welding, Basic Arc Welding Processes, Thermit Welding, Electron – Beam Welding, Laser – Beam Welding. Solid State Welding: Cold Welding, Ultrasonic Welding, Friction Welding, Resistance Welding and Explosive Welding. Principles and applications of Brazing and Soldering.

CASE STUDY:

Study of production processes involved in mechanical manufacturing.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Kalpakjian, S., "Manufacturing Engineering and Technology", Pearson education India, 4th Edition, 2009.
2. Hajra Choudhury, S.K., and Hajra Choudhury, A.K., "Elements of Workshop Technology", Volume I and II, Media Promoters and Publishers Private Limited, Mumbai, 1997.
3. Paul Degarma E, Black J.T., and Ronald A. Kosher, "Materials and Processes in Manufacturing", Hall of India, 8th Edition, 2008.
4. Sharma P.C., "A Textbook of Production Technology", S. Chand and Co., Ltd., 2009.

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U14MCT402 INDUSTRIAL ELECTRONICS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Relate the basic semiconductor physics to the properties of real power semiconductor devices and differentiate from low power devices.

CO2: Analyze the different EMI problem in switching.

CO3: Describe the concepts of operation of AC-DC converters in steady state of both continuous and discontinuous modes.

CO4: Design simple thyristor triggering circuit and provide theoretical solution to use thyristor as switch.

CO5: Use basic converter topologies for converter applications.

CO6: Identify the proper gating sequence and control circuit in operating the single phase and three phase inverter circuits.

CO7: Classify and design choppers for simple electrical application.

CO8: Analyze the performance parameter, various techniques for analysis and design of AC voltage controller and also list the various control schemes in cycloconverter.

CO9: Relate the use of power electronic devices in the real time applications and able to solve simple problems.

Pre-requisite

U14MCT201 Electronic Devices and Circuits

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	M								
CO2	S	S	M							
CO3	S									
CO4	S		S		S	S				
CO5					S	S				M
CO6		S	M							
CO7		M	M		M					
CO8		S			M					

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II	Course end survey

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Internal test III End semester Examination Assignment	

POWER SEMICONDUCTOR DEVICES 9Hours

Classification of Power semiconductor devices, characteristics, construction, application and theory of operation of power diode, power transistor, thyristors. Device specifications and ratings, working of Diac, Triac, IGBT, GTO and other power semi conductor devices. EMI-Types of EMI problems – di/dt protection and dv/dt protection - snubbers – shielding - grounding-filtering – twisted shielding wires-soft switching and methods of solving in industrial electronics.

PHASE CONTROLLED CONVERTERS 9Hours

Single phase full converters, 3 phase half converter and 3 phase full converter – inverter operation – input power factor – effect of source inductance- use of flywheel diode in controlled rectifier configurations– Thyristor triggering circuits.

INVERTERS AND CHOPPERS 9Hours

Classification of inverters, Thyristor inverters, Voltage and Current Communicated inverters, PWM inverters, Principle of Chopper, Chopper classification – step up and step down Chopper - Types of regulators.

A. C. VOLTAGE CONTROLLERS AND CYCLO-CONVERTERS 9Hours

Single phase AC voltage controller – multistage sequence control – step up and step down cycloconverters – three phase to single phase and three phase cycloconverters.

INDUSTRIAL APPLICATIONS 9Hours

Solid-state switching circuits, Relays, Electronic Timer, Saw tooth generator, applications in Industrial process control, Motor drive applications, Electronic regulators, etc., Induction heating, Dielectric Heating.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. P S Bimbhra , "Power Electronics" Tata McGraw Hill, 2012
2. Rashid, M.H., "Power Electronics – Circuits Devices and Application", Prentice Hall International, New Delhi, 4th Edition, 2013.
3. Dubey, G.K., Doradia, S.R., Joshi, A. and Singh, R.M., "Thyristorised Power Controllers", Wiley Eastern Limited, 2nd Edition, 2010.
4. Joseph Vithayathil, "Power Electronics – Principle and Applications", Tata McGraw-Hill Inc, New Delhi, 2010.

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U14MCT403

MECHANICS OF SOLIDS FOR MECHATRONICS

L	T	P	C
3	1	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Recognize the elastic response of the materials and calculate the stresses and deflection in simple and compound bars

CO2: Find the stresses in bi-axial load system and strain energy for different loads

CO3: Develop the shear force, bending moment diagram and calculate the stresses induced in various types of beams

CO4: Predict the slope and deflection of beams for various loading conditions and find the crippling load for a column with different end conditions

CO5: Determine the power transmitting, torque carrying capacities of the circular shafts

Pre-requisite

1. U14MET201 Engineering Mechanics
2. U14MAT101 Engineering Mathematics -I
3. U14MAT201 Engineering Mathematics - II

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	M	W							
CO2	S	M	W							
CO3	M	S								
CO4	M	S	M							
CO5	M	S	W							

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

ELASTIC RESPONSE OF MATERIALS **12Hours**

Introduction to elastic response – stresses (tensile, compressive, shear & bending) & strength – strain and deformation, stress-strain curve for steel - Stresses and deformation of simple and compound bars under axial loads - Elastic constants and their relations - Introduction to types of failures- strength and stiffness based design-Thermal stresses and creep. **Tutorials**:

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Measurement of tensile strength and modulus of elasticity.

BI-AXIAL STRESSES AND STRAIN ENERGY 12Hours

Principal stresses – Introduction, significance, calculation of principal stresses - Mohr's circle to find principal stresses - Strain energy in tension, compression, Impact loading, shear, torsion, bending - Elements of fracture mechanics.

STRESSES IN BEAMS 12Hours

Types of beams: supports and loads – Cantilever, Simply supported and Overhanging beams - Shear force and bending moment diagrams.

Stresses in beams – theory of simple bending and its applicability for actual conditions effect of shape of beams on stress induced - Bending stress and flexural strength.

Tutorials: Measurement of flexural strength - Shear stresses in beams.

DEFLECTION OF BEAMS 12Hours

Elastic curve– Evaluation of beam deflection and slope: Double integration method & Macaulay's method

Columns: End conditions, equivalent length – Euler's equation and its limitations – slenderness ratio – Rankine's formula for columns

TORSION OF CIRCULAR SECTIONS AND DESIGN OF PRESSURE VESSELS 12Hours

Analysis of torsion of circular bars – shear stress distribution – twist and torsional stiffness – Bars of solid and hollow circular sections - Thin cylinders and shells – Hoop stress and longitudinal stresses.

Theory: 45Hr **Tutorial: 15 Hr** **Total Hours: 60**

REFERENCES

1. S. Ramamrutham, "Strength of materials", 18th Edition, Dhanpat Rai Publishing Company , 2014
2. S S Rattan, "Strength of materials", Second edition, McGraw Hill, 2014
3. Beer & Johnston, "Mechanics of materials", Third edition, 2007
4. W A Nash, "Strength of materials", 4th Edition , Tata McGraw Hill, 2011
5. MIT courseware

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U14MCT 404 DYNAMICS OF MACHINERY

L	T	P	C
3	1	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Differentiate and calculate various forces acting on rigid bodies under dynamic conditions

CO2: Explain the significance of balancing and solve balancing problems related to rotating and reciprocating masses

CO3: Differentiate free and forced vibration and their importance in design

CO4: Calculate the response for free and forced vibration of systems having single degree of freedom

CO5: Summarize and determine various parameters involved in controlling mechanisms such as governors and gyroscopes

Pre-requisite

U14MET201 Engineering Mechanics

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	S								
CO2	S			S						
CO3	S								S	
CO4		S		S						
CO5	S			S					S	

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

FORCE ANALYSIS **13Hours**

Rigid Body dynamics in general plane motion – Equations of motion.-Dynamic force analysis – Inertia force and Inertia torque –D'Alemberts principle –The principle of superposition – Dynamic Analysis in Reciprocating Engines – Gas Forces- Equivalent masses-Bearing loads - Crank shaft Torque- Turning moment diagrams–Flywheels– Engine shaking Forces – Cam dynamics-Unbalance, Spring Surge and Windup.

BALANCING **12Hours**

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Static and dynamic balancing - Balancing of rotating masses - Balancing a single cylinder Engine - Balancing of Multi cylinder Engines: Inline and V-Engines - Balancing of linkages - Introduction to balancing machines.

FREE VIBRATION **13Hours**

Basic features of vibratory systems - idealized models, Basic elements and lumping of parameters- Degrees of freedom – Single degree of freedom – Free vibration- Equations of motion-natural frequency-Types of Damping- Damped vibration-critical speeds of simple shaft-Torsional systems: Natural frequency of two and three rotor systems.

FORCED VIBRATION **9Hours**

Response to periodic forcing - Harmonic Forcing - Forcing caused by unbalance-Support motion - Force transmissibility and amplitude transmissibility - Vibration isolation. Significance of vibration exposure and control.

MECHANISM FOR CONTROL **13Hours**

Governors: Types - Centrifugal governors: Gravity and spring controlled – Inertia governors - Controlling Force – Gyroscopes: Gyroscopic forces and Torques - Gyroscopic stabilization - Gyroscopic effects in Automobiles, ships and airplanes.

CASE STUDY:

Isolation of vibrations in Automobiles - Engine - Suspensions.

Theory: 45Hr **Tutorial: 15 Hr** **Total Hours: 60**

REFERENCES

1. Rattan S. S., "Theory of Machines", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2nd Edition, 2007.
2. R.S. Khurmi, J.K. Gupta "Theory of machines", S. Chand & Company Ltd, New Delhi, 2003.
3. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 2003.
4. Ghosh A. And Mallick A.K., "Theory of Mechanisms and Machines", Affiliated East-West Press, Pvt. Ltd., New Delhi, 2000
5. Shigley J.E. and Uicker J.J., "Theory of Machines and Mechanisms", McGraw-Hill, Inc., 2003.
6. Rao J.S. and Dukkipati R.V., "Mechanism and Machine Theory", Wiley-Eastern Limited, New Delhi, 2006.
7. John Hannah and Stephens R.C., "Mechanics of Machines", Viva low-Priced Student Edition, 1999.
8. Sadhu Singh, "Theory of Machines", Pearson Education, 2nd Edition, 2008.

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U14MCT405

DIGITAL ELECTRONICS AND MICROPROCESSOR

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Use number systems, Boolean algebra and explain various digital logic families.

CO2: Apply basic logic gates to form simple circuits and can simplify logic circuits using K-Map technique.

CO3: Design combinational logic circuits using logic Gates and explain simple memory systems.

CO4: Design flip flops and realize one flip flop using the other.

CO5: Design counters and construct their timing diagrams.

CO6: Explain the architecture of 8085 microprocessor and their peripheral ICs (8255, 8279 and 8251 A).

CO6: Use 8085 Instruction set and explain their timing diagram for each operations during execution.

CO7: Write assembly language program for 8085 for a given applications using different addressing modes.

CO8: Map memory and I/O devices and explain the interrupt and DMA process.

Pre-requisite

U14MCT201 Electronics Devices And Circuits

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S									
CO2	S		W							
CO3		S	S							
CO4		S	M							
CO5		S	S		M					
CO6	S									
CO7	S									
CO8					S	M	S	M		
CO9	S									

Course Assessment methods:	
Direct	**Indirect**
Internal test I	Course end survey

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Internal test II Internal test III End semester Examination Assignment	

NUMBER SYSTEMS, DIGITAL LOGIC FAMILIES AND BOOLEAN LOGIC **9Hours**

Introduction to Number systems: Binary, Octal, Hexadecimal, BCD, Gray code, Excess 3 code - Binary arithmetic: 1's complements, 2's complements, and Code conversions -Digital Logic Families: TTL, CMOS, NMOS, ECL- Performance comparison of various logic families- Boolean algebra: Basic Postulates and theorems, Switching functions, Canonical forms, Logic gates- Simplification using K-maps and Implementation using logic gates.

COMBINATIONAL CIRCUITS **9Hours**

Problem formulation and design of combinational circuits: adder, subtractor, Serial adder and Subtractor - Parallel adder and Subtractor- Carry look ahead adder- BCD adder, Magnitude Comparator , parity checker Encoder , decoder, Multiplexer/ Demultiplexer , code converters, Function realization using gates and multiplexers. Implementation of Combinational circuits using Multiplexers and Demultiplexers- Memory: PROMs and PLAs.

SEQUENTIAL CIRCUITS **9Hours**

General model of sequential circuits: Latch, Flip Flops, Level triggering, Edge triggering, Master slave configuration- Realization of one flip flop using other flip flop- Registers-Counters: Binary counters, Modulo–n counter, Decade, BCD counters, Ring counter and Johnson counter with their timing diagram.

MICROPROCESSOR 8085 **9Hours**

Organization of 8085: Architecture, Internal Register Organization and Pin Configuration – Instruction Set of 8085 – addressing modes - instruction and machine cycles with states and timing diagram - 8085 assembly language programming.

MEMORY AND I/O INTERFACING **9Hours**

Address space partitioning – address map – Address decoding – Designing decoder circuit for the given address map -I/O Interfacing- Data transfer schemes – programmed synchronous and asynchronous – Interrupt driven Transfer – interrupts- DMAs- Peripheral ICs*: 8255, 8279 and 8251 A

* Emphasis to be given on architecture with simple applications.

Total Hours: 45

REFERENCES

1. M. Morris Mano and M. D. Ciletti, "Digital Design", Prentice Hall of India Pvt. Ltd., New Delhi, 4th Edition, 2008.
2. Donald P.Leach, Albert Paul Malvino and Gautam Saha, "Digital Principles and Applications", Tata McGraw Hill Publishing Company Limited, New Delhi, Special Indian Edition, 8th Edition 2014.
3. S. Salivahanan and S. Arivazhagan, "Digital Circuits and Design", Second Edition, Vikas Publishing House Pvt. Ltd, New Delhi, 4th Edition, 2012.
4. Ramesh Gaonkar, "Microprocessor Architecture, Programming and Applications with the 8085" Penram International (India), 6th edition, 2013.
5. Aditya P Mathur, "Introduction to Microprocessor", Tata McGraw Hill, New Delhi 3rd

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edition, 2003.

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U14ME*P* 404 **MACHINE DYNAMICS LABORATORY**

L	T	P	C
0	0	3	1

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Relate the different characteristics of governors and verify gyroscopic relation.
CO2: Draw the cam profile with different followers and Study of jump phenomenon.
CO3: Identify the system response, natural frequency and resonance for free, forced, torsional vibrations and whirling of shaft.
CO4: Experimental verification of dynamic balancing of rotating masses, reciprocating masses.
CO5: Analyze and present the findings of experimental observations in both written and oral format.

Pre-requisite

1. U14MC*T* 403 – Dynamics of Machinery

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S			S				S	S	
CO2	S		M					S	S	
CO3	S			S				S	S	
CO4		M		M				S	S	
CO5								S	S	

Course Assessment methods:	
Direct	**Indirect**
Lab Exercises Model Exam. End Semester Practical Examination Assignment	Course end survey

LIST OF EXPERIMENTS

1. Governors - Determination of sensitivity, effort, etc. for watt, porter, proell, Hartnell governors
2. Cam - Study of jump phenomenon and drawing profile of the cam.
3. Motorized Gyroscope-Determination of Gyroscopic couple Verification of Laws.
4. Bifilar Suspension and Compound Pendulum – Determination of Moment of Inertia of Rod.
5. Turn Table – Determination of Moment of Inertia of Disc and Ring.
6. Epicyclic Gear Train Apparatus – Gear Ratio and Torques.

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7. Balancing of rotating masses (Static and Dynamic Balancing)
8. Balancing of reciprocating masses.
9. A) Helical Spring – Natural Frequency of Longitudinal Vibrations
   B) Transverse Vibrations Verification of Dunkerley's Rule.
10. Rotor Systems – Natural Frequency of Torsional Vibrations.
11. A) Whirling of Shaft – Determination of Critical Speed
    B) Vibrating Table – Determination of Transmissibility Ratio.

Experiments beyond the syllabus should be conducted

Total Hours: 45

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U14MC*P* 401 **INDUSTRIAL ELECTRONICS LABORATORY AND PROJECTS**

L	T	P	C
0	0	2	1

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Use different power electronic devices (SCR, MOSFET & IGBT) and collect data to plot their V-I characteristics.

CO2: Test three different firing circuits used for SCR and able to differentiate each technique based on their performance

CO3: Construct a converter circuit for a given application.

CO4: Control the speed of DC shunt motor using phase controlled converter.

CO5: Analyze and present the findings of experimental observations in both written and oral format

Pre-requisite

1. U14MCT 401 - INDUSTRIAL ELECTRONICS

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	S								
CO2		S				S				
CO3			S		M					
CO4	S		W							
CO5								S	S	

Course Assessment methods:	
Direct	**Indirect**
Lab Exercises Model Exam. End Semester Practical Examination Assignment	Course end survey

LIST OF EXPERIMENTS

1. Study of SCR, MOSFET & IGBT characteristics.
2. UJT, R and RC firing circuits for SCR.
3. Voltage & current commutated chopper.
4. SCR / TRIAC phase control circuits.
5. Study of half controlled & fully controller converters.
6. Speed control of DC shunt motor using three phase fully controlled converter.
7. SCR single-phase cycloconverters.
8. SCR series and parallel inverters.

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9. IGBT Chopper.
10. IGBT based PWM inverter (single phase).

Experiments beyond the syllabus should be conducted

Total Hours: 45

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U14MCP 402 **MANUFACTURING TECHNOLOGY LABORATORY**

L	T	P	C
0	0	2	1

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Select the appropriate manufacturing process by which the given component can be produced

CO2: Read and interpret the shop floor drawings.

CO3: Inspect the manufactured components using suitable measurement techniques

Pre-requisite

1. U14MCT401 Manufacturing Technology

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	M		M				S			
CO2	S			S						
CO3	M		W				S			

Course Assessment methods:	
Direct	**Indirect**
Lab Exercises Model Exam. End Semester Practical Examination Assignment	Course end survey

LIST OF EXPERIMENTS

1. Experiment on mechanical measurement (linear, angular, surface measurement).
2. Metal spinning
3. Turning : Step, taper
4. Thread cutting
5. Tapping
6. Boring
7. Grinding (surface, cylindrical and center less)
8. Cutting key way (shaping and slotting machine)
9. Different types of Fits
10. Flatness measurement
11. Thread measurement using two and three wire method.

Additional experiments individual projects for model exams: time is limited to one day

12. Knuckle joint
13. Universal coupling
14. Flange coupling using Plaster of Paris (POP).

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15. Different types of castings using PoPs
16. Different types of coupling with key ways
17. Simple mechanical components involving multiple operations.
18. Machining of Cam profile : eccentric cam

Experiments beyond the syllabus should be conducted

Total Hours: 45

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U14GHP401	NATIONAL AND GLOBAL VALUES (Common to all branches of Engineering and Technology)	L	T	P	C
		1	0	1	1

Course Outcomes

After successful completion of this course, the students should be able to

- **CO1:** Act as a good and responsible citizen.
- **CO2:** Conserve and protect eco cycle.
- **CO3:** Voluntarily work with global welfare organization and provide solution for global peace.
- **CO4:** Invent his Technical design by considering humanity and nature

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1						S	M		M	S
CO2							S			
CO3						M	W	M	M	
CO4						S	S			
CO5						S	M		M	S

Course Assessment methods:

Direct	Indirect
Continuous Assessment End Semester Examination	Course end survey Attitude Behavior

ROLE OF A RESPONSIBLE CITIZEN **4 Hours**

Citizen - its significance–National and Global perspectives.

Practical: Group discussion on National and Global values

GREATNESS OF INDIAN CULTURE **2 Hours**

Emerging India – past and present, about Culture, Morality and spirituality– Beauty of Unity in diversity - Impact of western culture in India and Indian culture over other countries.

Practical: Demonstration and impact measurements of simple and good actions.

GLOBAL WELFARE ORGANISATIONS **2 Hours**

Education – Health – Nature – Peace

Practical: Organizing an event linking with one of the Organizations In campus /off campus.

PRESERVING NATURE **2 Hours**

Appreciating the flora and fauna on Earth - Importance of Ecological balance – Conservation.

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Practical: Trekking, field visit.

GLOBAL PEACE **4 Hours**

One World and One Humanity - Global Peace.

Global personalities: Thiruvalluvar, Vallalar, Vivekanadar, Mahatma Gandhi,Vethathiri Maharishi – Plans for world peace.

Practical: Group discussion on individual plans for world peace.

GENERAL PRACTICAL **16 Hours**

Simplified physical Exercise – Kayakalpa practice (Follow up practice) – Meditatyion - Theory & Practice

Pranayama : Bhastrika, Kapala Bhati, Nadi suddhi, Sikari, Sitali.

Mudhra : Chin Mudhra, Vayu Mudhra, Shunya Mudhra, Prithvi Mudhra, Surya Mudhra, Varuna Mudhra, Prana Mudhra, Apana Mudhra, Apana Vayu Mudhra, Linga Mudhra, Adhi Mudhra, Aswini Mudhra..

Theory: 14 Hrs **Practical: 16 Hrs** **Total Hours: 30**

REFERENCES

1. Drunvalo Melchizedek, "The Ancient Secret of the Flower of Life", Vol. 1, Light Technology Publishing; First Edition, 1999..
2. Dr.M. B. Gurusamy, "Globalisation – Gandhian Approach", Kumarappa Research Institution, 2001.
3. Vethathiri's Maharishi's, "Karma Yoga: The Holistic Unity" The World Community Service Centre, Vethathiri Publications, 1994.
4. Vethathiri's Maharishi's, "World peace" The World Community Service Centre, Vethathiri Publications, 1957.
5. Vethathiri's Maharishi's, "Atomic Poison" The World Community Service Centre, Vethathiri Publications, 1983.
6. Vethathiri's Maharishi's, "The World Order of Holistic Unity", The World Community Service Centre, Vethathiri Publications, 2003.
7. Swami Vivekananda, "What Religion is" 41th edition, The Ramakirshna Mission Institute of Culture, 2009.

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SEMESTER V

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U14MCT 501 SIGNALS AND SYSTEMS

L	T	P	C
3	1	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Explain the role of signals in the design of Mechatronics systems and also classify signals and systems based on their properties

CO2: Describe the operations carried out on signals and anticipate their effect on signals

CO3: Distinguish continuous and discrete signals and able to convert continuous signal into discrete by applying sampling theorem

CO4: Anticipate the problems related to sampling and their effect on signal reconstruction.

CO5: Express the importance of correlation and power spectral density in signal analysis.

CO6: Derive and compute the system response for standard test signal inputs for LTI systems

CO7: Model a system using block diagram, integral-differential and state –space techniques

CO8: Apply Fourier transform technique to analyze systems in frequency domain.

CO9: Apply Laplace transform technique to analyze systems in frequency domain

Pre-requisite

1. U14MAT101 Engineering Mathematics – I
2. U14MAT201 Engineering Mathematics – II

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S									
CO2	S	M								
CO3	S									
CO4	S		W							
CO5	S									
CO6		S	S		S					
CO7		S	S		M					W
CO8	S		M							
CO9	S		M							

Course Assessment methods:

Direct	Indirect
Internal test I	Course end survey

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Internal test II Internal test III End semester Examination Assignment	

INTRODUCTION TO SIGNALS AND SYSTEMS **9Hours**

Importance of signals and systems: Mechatronics system and data transmission as examples- Classification of signals: Continuous time and discrete time, even, odd, periodic and non periodic, deterministic and non deterministic, energy and power- **Operations on signals**: Amplitude scaling, addition, multiplication, differentiation, integration (accumulator for DT), time scaling, time shifting and folding, precedence rule- **Elementary signals**: exponential, sine, step, impulse and its properties, ramp, rectangular, triangular, signum, sinc- **Systems**: Definition, Classification: linear and non linear, time variant and invariant, causal and non-causal, static and dynamic, stable and unstable, invertible.

SAMPLING AND RECONSTRUCTION **9Hours**

Representation of continuous time signals by its samples - Sampling the Nyquist theorem – Sinc interpolation - Reconstruction of a signal from its samples, aliasing – discrete time processing of continuous time signals, sampling of band pass signals. Sampling of Discrete Time signals- Practical reconstruction using MATLAB.

CORRELATION AND SPECTRAL DENSITY **9Hours**

Definition of Correlation and Spectral Density, correlogrm, analogy between correlation, Covariance and convolution, conceptual basis, auto-correlation, cross correlation, energy/power spectral density, properties of correlation and spectral density, inter relation between correlation and spectral density.

SYSTEM ANALYSIS **12Hours**

System modeling: Input output relation, impulse response, block diagram, integro-differential equation and state-space representation - Definition of impulse response, convolution integral, convolution sum, computation of convolution integral using graphical method for unit step to unit step, unit step to exponential, exponential to exponential and unit step to rectangular, rectangular to rectangular only. Computation of convolution sum by all methods. Properties of convolution, system interconnection, system properties in terms of impulse response and step response in terms of impulse response.

SYSTEM ANALYSIS IN FREQUENCY DOMAIN USING FOURIER TRANSFORM **9Hours**

Definition and necessity of CT and DT Fourier series and Fourier transforms- Analogy between CTFS, DTFS and CTFT, DTFT- CT Fourier series, CT Fourier transform and its properties, problem solving using properties: amplitude spectrum, phase spectrum of the signal and system - Interplay between time and frequency domain using sinc and rectangular signals. Limitations of FT and need of LT and ZT.

SYSTEM ANALYSIS IN FREQUENCY DOMAIN USING LAPLACE TRANSFORM **12Hours**

Definition and its properties, ROC and pole zero concept. Application of Laplace transforms to the LTI system analysis. Inversion using duality, numerical based on properties. Signal analysis using LT.

Theory: 45Hr **Tutorial: 15 Hr** **Total Hours: 60**

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REFERENCES

1. Simon Haykin and Barry Van Veen ,"Signals and Systems", 2nd edition, Wiley India.
2. B.P. Lathi, "Linear Systems and Signals", 2nd Edition, Oxford University Press, 2004.
3. Alan V.Oppenheim, Alan S. Willsky with S. Hamid Nawab, "Signals and Systems", Pearson Education, 2nd Edition, 1997.
4. Mrinal Mandal and Amrit Asif,"Continuous and Discrete Time Signals and Systems", Cambridge University Press, 2007.
5. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Pearson India, 2007.

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U14MCT502 **MICROCONTROLLER AND EMBEDDED SYSTEMS**

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Differentiate microcontroller from microprocessor and explain the general architecture of microcontrollers

CO2: Explain the applications of micro controllers and differentiate few microcontroller cores based on their construction and applications

CO3: Summarize the architecture, memory organization and internal communication of 8051 micro controllers.

CO4: Program, 8051 using different addressing modes and effectively use the timers, counters and interrupts for a given application

CO5: Distinguish ARM 7 from 8051 and write program in ARM7

CO6: Describe the architecture of real time operating systems with inter task communication

CO7: Design embedded system scheme for few real time domestic, auto and space applications

Pre-requisite

1. U14MCT 405 Digital Electronics And Microprocessor

CO/PO Mapping										
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak										
COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S									
CO2	S	W	M							
CO3	S									
CO4	S		M	M						M
CO5	S		M		M	M				
CO6	S									
CO7			S	S		S				S

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

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INTRODUCTION TO EMBEDDED SYSTEMS **6Hours**

Overview of Embedded Systems: Architecture, Application areas-Categories of embedded systems-specialties of embedded systems- Recent trends in embedded systems- Brief introduction to embedded microcontroller cores: CISC, RISC, ARM and DSP.

THE MICROCONTROLLER ARCHITECTURE **8Hours**

Introduction to 8051 Microcontroller: Architecture, Pin configuration, Memory organization, Input /Output Ports, Counter and Timers, Serial communication and Interrupts.

ASSEMBLY LANGUAGE PROGRAMMING OF 8051 **9Hours**

Instruction set, Addressing modes, Development tools, Assembler Directives, Programming based on Arithmetic & Logical operations, I/O parallel and serial ports, Timers & Counters, and ISR

ARM 7 ARCHITECTURE **10Hours**

Architectural inheritance, Detailed study of Programmer's model, ARM Development tools, Instruction set: Data processing, Data transfer, Control flow- Addressing modes- Writing simple assembly language programs- Pipelining, Brief introduction to exceptions and interrupts handling.

EMBEDDED / REAL TIME OPERATING SYSTEM **8Hours**

Architecture of kernel, Task and Task scheduler, Interrupt service routines, Semaphores and shared data, Mutex, Mailboxes, Message queues, Event registers, Pipes, Signals, Timers, Memory management, Priority inversion problem. Off-the-Shelf Operating Systems- Embedded Operating Systems, Real Time Operating System (RTOS) and Handheld Operating Systems.

EMBEDDED SYSTEM - DESIGN CASE STUDIES **4Hours**

Washing machines - Cruise control - antilock braking systems - satellite launch control.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. M. A. Mazidi, J. G. Mazidi and R. D. McKinlay, "The 8051 Microcontroller & Embedded systems", Pearson, 2nd Edition, 2008.
2. Kenneth J. Ayala and Dhananjay V. Gadre, "The 8051 Microcontroller & Embedded Systems using Assembly and C" Cengage Learning (India edition), 2010
3. K. V. Shibu, "Introduction to Embedded Systems" McGraw Hill, 2009.
4. Andrew N. Sloss, Dominic Symes and Chris Wright, "ARM system developer's guide", Elsevier, 2010.

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U14MC*T*503 CONTROL ENGINEERING

L	T	P	C
3	1	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Know the significance to control engineering and the basic construction of control systems

CO2: Write mathematical equations for model mechanical, electrical systems and can able to compute transfer function using block diagram and signal flow graph methods

CO3: Analyze the 1st and 2nd order systems in time domain for various test signals

CO4: Calculate steady state errors and derive generalized error series in the time domain analysis

CO5: Analyze the 1st and 2nd order systems in frequency domain using Bode and Polar plots

CO6: Calculate the stability of the system using Routh Hurwitz, Nyquist and Root Locus techniques

CO7: Define process and write process equations for a given problem

CO8: Explain and draw the response curves of continuous and discontinuous controllers and develop circuits using pneumatic and electronic systems

CO9: Explain the importance of controller tuning with the help of Z-N method and also explain various special controllers.

Pre-requisite

1. U14MAT101 Engineering Mathematics – I
2. U14MAT201 Engineering Mathematics – II
3. U14MCT501 Signals And Systems

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S									
CO2	S	S							S	
CO3		M	S							
CO4	S			S						
CO5	S			S						
CO6		S	S	S						
CO7	S	M	M						S	S
CO8		S	S		S					
CO9	S		S	S						

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Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION **12Hours**

Open loop and closed loop systems - Examples - Elements of closed loop systems - Transfer function of elements - Modeling of physical systems - Mechanical systems - Translational and Rotational systems - Electrical networks - Block diagram – Signal flow graph - Mason's gain formula. Transfer function - Transfer function of DC servomotor, AC servomotor.

TIME DOMAIN ANALYSIS **12Hours**

Standard Test signals – Time response of second order system - Time domain response Performance criteria - Types of systems - Steady state error constants - Generalized error series.

FREQUENCY RESPONSE OF SYSTEMS **12Hours**

Frequency domain specifications - correlation between time and frequency response for second order systems-Bode plots- Assessment of stability - Gain Margin and phase Margin Assessment – Lead, lag and Lead lag compensation using Bode Plot - Polar plots. **Tutorials**: Bode plot and polar plot using MATLAB.

STABILITY OF CONTROL SYSTEMS **12Hours**

Characteristic equation - Routh Hurwitz criterion of stability - Nyquist stability - Nyquist stability criterion - Assessment of relative stability – Gain and Phase Margin. Root Locus concept - Root Locus procedure - Root Locus construction - Root contours- **Tutorials**: Stability analysis of higher order systems using MATLAB

PROCESS CONTROL **12Hours**

Process definition, equation and dynamics - Discontinuous and continuous controllers- Realization of both the controllers using Electronics and pneumatics- Tuning of controller: Ziegler-Nicholas PID controller tuning- **Special controllers**: feed forward, ratio, cascade control and adaptive control.

SELF STUDY: Transfer function of Synchro and stepper motor

Theory: 45Hr **Tutorial: 15 Hr** **Total Hours: 60**

REFERENCES

1. I J Nagrath, and M .Gopal, “Control Systems Engineering", Prentice Hall of India, New Delhi, 5th edition, 2009.
2. Katsuhiko Ogata, “Modern Control Engineering”, Prentice Hall India, 5th Edition, 2010.
3. R.C Dorf and R.H. Bishop, “Modern Control systems”, Pearson India, 12th Edition, 2014.
4. Curtis D. Johnson, “Process control Instrumentation technology”, Prentice Hall India, 2006.
5. S. K. Singh, “Computer aided process control”, Prentice Hall India, 2004.

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U14MC*T*504 MECHATRONICS FOR MACHINING

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Explain the fundamentals of CNC machines , differentiate the advantages and disadvantages of different types of CNC machines

CO2: Describe the constructional features of CNC machines

CO3: Develop a CNC Part programming for the basic milling and turning operations

CO4: Explain the working principle of unconventional machining processes based on energy factor.

Pre-requisite

1. U14MCT 401 Manufacturing Technology

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S		W							
CO2	S		W							
CO3	S		S							W
CO4	S		W				S			

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION **6Hours**

History - Classification, Comparison between conventional and non-conventional machining process - Introduction to Computer Numerical Control, Features of CNC Machines - Different types of CNC machines – Advantages and disadvantages of CNC machines DNC and Adaptive control - Maintenance features of CNC Machines.

COMPONENTS OF CNC MACHINES AND TOOLING **10Hours**

Description of CNC components: Structure, Drive Mechanism, gearbox, Main drive, feed drive, Spindle Motors, Axes motors - Spindle bearing - Slide ways – Re circulating ball screws – Backlash measurement and compensation, linear motion guide ways - Tool magazines, ATC, APC, Chip conveyors - Types of measuring systems in CNC machines –Magnetic Sensors for Spindle Orientation. Qualified and pre-set tooling – Principles of location – Principles of

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clamping – Work holding devices. Retrofitting of Conventional Machine Tools.

CNC PART PROGRAMMING AND MAINTENANCE 11Hours

Part Program Terminology- G and M Codes – Types of interpolation Methods of CNC part programming – Manual part programming: Fixed cycle, canned cycle – Computer Assisted part programming – APT language – CNC part programming using CAD/CAM-Introduction to Computer Automated Part Programming.

Factors influencing selection of CNC Machines - Practical aspects of introducing CNC machines in industries.

UNCONVENTIONAL MACHINING PROCESSES I 9Hours

Abrasive Jet Machining – Water Jet Machining – Ultrasonic Machining - Working Principles – Equipment – Process parameters – MRR-Variation in techniques used – Applications.

Electric Discharge Machining (EDM) - Working Principles-Equipments-Process Parameters-MRR- Electrode / Tool – Power Circuits-Tool Wear – Dielectric – Flushing – Wire cut EDM – Applications.

UNCONVENTIONAL MACHINING PROCESSES II 9Hours

Chemical Machining and Electro-Chemical Machining - Etchants – Maskant-Techniques of applying maskants-Process Parameters -Principles of Electro Chemical Machining- Applications - Laser Beam machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining (EBM) ,Principles-Equipment-Types-Beam control techniques – Applications.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Radhakrishnan P., "Computer Numerical Control Machines", New Central Book Agency, 2011.
2. Groover, M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall, 2007.
3. YoremKoren, "Computer Control of Manufacturing Systems", Pitman, London, 1987.
4. Vijay.K. Jain "Advanced Machining Processes", Allied Publishers Pvt. Ltd., New Delhi, 2002.
5. Benedict. G.F. "Nontraditional Manufacturing Processes", Marcel Dekker Inc., New York, 1987
6. Pandey P.C. and Shan H.S. "Modern Machining Processes", Tata McGraw-Hill, New Delhi, 1980.

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U13MC*T*505 MAINTENANACE ENGINEERING

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Differentiate preventive, predictive and failure maintenance
CO2: Prepare a maintenance plan and explain the cost benefit analysis
CO3: Describe the friction, wear and also explain the oil analysis
CO4: Explain the vibration signature analysis in condition based monitoring with respect to rotating machines
CO5: Distinguish and explain various NDT methods and their use
CO6: Describe the role of reliability and their use in industry

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1				S			S			
CO2							S		S	
CO3		M		S						
CO4				S						
CO5				S		W				
CO6							S			

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

OVERVIEW OF MAINTENANCE AND RELIABILITY ENGINEERING **9Hours**

Introduction - Fundamentals of Maintenance Engineering- Scope of industrial preventive/predictive maintenance programs - Definition of terminology- An example of establishing equipment maintenance program- Overview of condition-based maintenance technologies- Maintenance planning, management and designing an effective maintenance

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organization- Information systems organization and asset management - Evaluating maintenance performance- Cost-benefit analysis.

RELIABILITY ENGINEERING AND FAILURE MODELS 9Hours

Reliability, availability and maintainability - Reliability models and failure distributions - Reliability function estimation - Residual life estimation as a prognosis activity- model development and forecasting - System reliability by Monte Carlo Simulation Technique.

TRIBOLOGY AND LUBRICATION OIL ANALYSIS 9Hours

Friction wear and lubrication, friction & wear mechanisms, prevention of wear, types of lubrication mechanisms, lubrication processes. Lubricants - types, general and special purpose, additives- Classification of lube oil test methods, degradation of lubricants, Lube oil contamination analysis- Lube oil wear particle analysis- seal & packings.

VIBRATION MEASUREMENT AND CONDITION MONITORING 9Hours

Vibration and its causes- Classification of frequency ranges- Imbalance, misalignment, looseness, bearing defects, and their characteristic frequencies- Understanding vibration of a second order system- Instrumentation for vibration monitoring- Description of a typical vibration monitoring system- Vibration signatures, data trending, and alarming techniques. turbine imbalance, pump misalignment, pump looseness, boiler feed water pump anti-friction bearing monitoring, pump journal bearing monitoring, rolling mill gearbox problem, transient vibration analysis.

NON-DESTRUCTIVE TESTING 9Hours

Ultrasonic testing- Acoustic Emission- Dye penetrant testing- Eddy Current testing- Magnetic particle inspection: Principles, types, probes and with simple applications such as weldment testing and flaw detection

CASE STUDY: Reliability study of rotating machinery and heat exchangers - vibration monitoring

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Keith Mobley, Lindley Higgins and Darrin Wikoff, "Maintenance Engineering Handbook", McGraw-hill, 2008.
2. B. K. N. Rao, "Handbook of Condition Monitoring", Elsevier, 1996
3. Gupta A.K., "Reliability, maintenance and safety engineering", University science press, New Delhi, 1st edition, 2009.
4. Baldev Raj, T. Jayakumar and M. Thavasimuthu, "Practical Non-destructive Testing", Woodhead Publishing, 2002.

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U14MC*T*506 INDUSTRIAL AUTOMATION I

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Describe the concept of fluid power and use symbols of various components used in fluid power

CO2: Outline the importance of PLC, DCS, SCADA in industrial automation

CO3: Design fluid power circuits by selecting appropriate control valves and actuators

CO4: Describe the hardware and architecture of PLCs and also identify the analogy of relay logic components

CO5: Write PLC program using ladder diagram for simple applications

CO6: Summarize the common faults and troubleshooting methods for fluid power circuits

CO7: Summarize various maintenance procedures practiced in industry for PLC based control systems

Pre-requisite

1. U14MCT 304 Mechanics of Fluid for Mechatronics
2. U14MCT 405 Digital Electronics and Microprocessor

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S		M		M					
CO2	S		M		M					
CO3	S		S			W				
CO4	S		M							
CO5	S		S	M	S	W				
CO6	S						M	M		
CO7	S						M	M		

Course Assessment methods:

Direct	Indirect
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

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INTRODUCTION **5 Hours**

Role of automation in industries, Benefits of automation –Introduction to fluid power, Advantages of fluid power, Application of fluid power system - Types of fluid power systems - Introduction to automation tools: Low cost automation, PLC, DCS, SCADA - Automation strategy evolution.

COMPONENTS OF FLUID POWER SYSTEMS **12 Hours**

Classifications and working principles of Pumps – compressors – linear actuators – rotary actuators – directional control valves – pressure control valves – Proportional valves – Servo valves – flow control valves – accumulators - intensifiers

DESIGN OF FLUID POWER CIRCUITS **10 Hours**

Speed control circuits, synchronizing circuit and industrial application circuits – copying circuit and press circuit - accumulator circuits –Pneumohydraulic circuit - Electro Hydraulic circuits – Electro Pneumatic circuits - Sequential circuit design for simple applications using cascade method , step counter method and Karnaugh-Veitch mapping method

PLC HARDWARE MODULES AND PROGRAMMING **11 Hours**

CPU – processor's function – PLC system memory and application memory – input modules – output modules – module selection

Introduction to IEC 61131 - System functions – sequence control – ladder logic – programming sequences – limitation of ladder programming – logic instruction sets – standard PLC functions – special function relays – data handling instructions – arithmetic instructions – data manipulation – program subroutines – programming examples.

APPLICATION AND MAINTENANCE **7 Hours**

PLC applications in fluid power control- PLC as robot controller and FMS – PLC to factory automation – PLC in process control

Failure and trouble shooting in fluid power systems- PLC maintenance – internal PLC faults – faults external to PLC – programmed error – watch dogs – safety – hardware safety circuits – troubleshooting.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education Inc., 7th Edition 2009.
2. Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw-Hill, 2009.
3. James A. Sullivan, "Fluid Power: Theory and Applications ",C.H.I.P.S, 4th edition, 2007
4. Frank D. Petruzella, "Programmable Logic Controllers", McGraw-Hill Companies, 3rdEdition, March 2013.
5. Lukcas M.P., "Distributed Control Systems", Van Nostrand Reinhold Co., New York, 1986.
6. John W. Webb and Ronald A.Reis, "Programmable Logic Controllers – Principles and Applications", Prentice Hall Inc., New Jersey, 3rd Edition, 1995.
7. Krishnakant, "Computer Based Industrial Control", Prentice Hall of India, 1997.

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U13MC*P* 501 **INDUSTRIAL AUTOMATION I LABORATORY AND PROJECTS**

L	T	P	C
0	0	2	1

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Select the actuators and valves for the design of fluid power circuits

CO2: Design and simulate the fluid power circuits using software tool

CO3: Test the simulated output by constructing the fluid power circuits using suitable actuators and valves

CO4: Write a program to control various actuators using Microcontrollers and PLCs

CO5: Develop a simple process logic using relay module

CO6: Analyze and present the findings of experimental observations in both written and oral format

Pre-requisite

1. U14MCT 505 Industrial Automation
2. U14MCT502 Microcontrollers And Embedded Systems

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S		M					S	S	
CO2	S		M		S			S	S	
CO3	S		M	M	S			S	S	
CO4	S		S		S			S	S	
CO5	S		M					S	S	
CO6	S							S	S	

Course Assessment methods:	
Direct	**Indirect**
Lab Exercises Model Exam. End Semester Practical Examination Assignment	Course end survey

LIST OF EXPERIMENTS

1. Design and testing of the following hydraulic circuits:
   a. Pressure control
   b. Flow control
2. Design and testing of sequential circuit using an Electro hydraulic Trainer kit.

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3. Design and testing of hydraulic circuits using PLC
4. Design and testing of the following pneumatic circuits:
    a. Pressure control
    b. Flow control
5. Design and testing of Sequential circuit using an Electro pneumatic Trainer kit.
6. Design and testing of pneumatic circuits using Microcontroller.
7. Design and testing of pneumatic circuits using PLC
8. Simulation of basic hydraulic, pneumatic and electrical circuits using Automation Studio software.
9. PLC programming for industrial process system.
10. Process logic development using Relay Logic module.
11. PLC digital, analog signal interface with field devices.

Experiments beyond the syllabus should be conducted

Total Hours: 45

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U13MCP502 **CAD/CAM LABORATORY AND PROJECTS**

L	T	P	C
0	0	2	1

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Model and assemble a given three dimensional engineering components

CO2: Perform various analyses on simple structures for the application of different loads.

CO3: Generate CNC programs for a given components to work with CNC machines (Turning and Milling).

CO4: Analyze and present the findings of experimental observations in both written and oral format.

Pre-requisite

1. U14MCT503 Mechatronics in Machining Systems

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1		S			S					
CO2		S		M						
CO3		S			S				S	
CO4									S	

Course Assessment methods:

Direct	Indirect
Lab Exercises Model Exam. End Semester Practical Examination Assignment	Course end survey

LIST OF EXPERIMENTS

COMPUTER AIDED DESIGN AND ANALYSIS LAB

1. Solid modeling using SOLIDWORKS / ProE / CATIA / Autodesk software of given components / product assemblies (at least 2 components/product assemblies)
2. Analysis of engineering problems using FEA package (any 2 components)

LIST OF EQUIPMENTS

1. Any CAD Software
2. Any FEA Software

COMPUTER AIDED MANUFACTURING LAB

LIST OF EXPERIMENTS

1. Given a component drawing to write the manual part programming and execute on CNC

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Milling Machine

2. Generation of NC codes and simulation of tool path using Master CAM software.
3. Post processing of NC code file for various controllers(FANUC, SINUMERIC)

LIST OF EQUIPMENTS

1. CNC Lathe
2. CNC Milling Machine
3. Master CAM software
4. EDGECAM software
5. Computer Nodes

Experiments beyond the syllabus should be conducted

Total Hours: 45

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U14MCP 503	MICROPROCESSOR AND MICROCONTROLLER LABORATORY	L	T	P	C
		0	0	2	1

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Perform arithmetic operations in 8085 kit and simulator and 8051.
CO2: Perform signal conversion using 8085 Kit.
CO3: Generate and execute program to control the speed of DC and stepper motor using 8051/8085.
CO4: Write programs and interface sensors to measure temperature and load.
CO5: Generate waveform using embedded C software at a given port terminal.

Pre-requisite

1. U14MCT405 Digital Electronics and Microprocessor.

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S									
CO2			M	S						
CO3			S							
CO4	S		S	S						
CO5	S		S							

Course Assessment methods:	
Direct	**Indirect**
Lab Exercises Model Exam. End Semester Practical Examination Assignment	Course end survey

LIST OF EXPERIMENTS

1. Arithmetic operations (addition, subtraction, multiplication, ascending, descending) using 8085 and 8051.
2. Generation of specified time delay and display in CRO/ DSO.
3. Analog to digital conversion in 8085.
4. Digital to analog conversion in 8085.
5. Interface MATRIX keyboard with 8085.
6. Stepper motor controller in 8051
7. DC motor controller interface using 8051.
8. Interface an ADC and a temperature sensor to measure temperature using 8051.
9. Flash a LED connected at a specified output port terminal using 8085.
10. Interface LCD with 8051.

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11. Interface an ADC and a strain gauge to measure the given load using 8051.
12. Generation of waveform using embedded C software at a specified port terminal.

Experiments beyond the syllabus should be conducted

Total Hours: 45

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SEMESTER VI

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U14MC*T* 601 FUNCTIONAL PROGRAMMING

L	T	P	C
2	0	1	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Classify and make use of python programming elements to solve and debug simple logical problems.

CO2: Interpret the problem and able to identify checkpoints to create ordered programs.

CO3: Apply the concept of data structures to solve simple non deterministic problems

CO4: Make use of object oriented concepts to build real time applications

CO5: Use various functions to manipulate hold set of values

CO6: Solve complex problems using loop functions

CO7: Perform arithmetic operations and able to print output

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1			S		S					
CO2				S						
CO3				S						
CO4					S					
CO5					S					
CO6		S								
CO7	S									

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION TO FUNCTIONAL PROGRAMMING: PYTHON 3 Hours

Why Python is popular? - The Python Programming Language - What Is a Program? - What Is Debugging? – **Errors:** Syntax Errors, Runtime Errors and Semantic Errors - The first program- **Essentials for programming:** Values and Types, Variables, Variable Names, Keywords,

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Operators, Operands, Expressions, Statements- **Mode of programming**: Interactive Mode and Script Mode- Operations: Order of Operations and String Operations – Comments.

FUNCTIONS, CONDITIONALS AND RECURSION **6 Hours**

Function Calls - Type Conversion Functions - Math Functions – Composition - Adding New Functions - Definitions and Uses - Flow of Execution - Parameters and Arguments - Variables and Parameters Are Local- Stack Diagrams - Fruitful Functions and Void Functions - Why Functions?- Importing with from. Modulus Operator - Boolean Expressions - Logical Operators - Conditional Execution - Alternative Execution - Chained Conditionals - Nested Conditionals - Stack Diagrams for Recursive Functions - Infinite Recursion - Keyboard Input.

FRUITFUL FUNCTIONS AND ITERATIONS **4 Hours**

Significant functions : Return Values , Incremental Development, Composition, Boolean Functions, More Recursion, Leap of Faith and checking types - **Iterations:** Multiple Assignment, Updating Variables, The while Statement, break, Square Roots and Algorithms.

STRINGS, LISTS AND DICTIONARIES **8 Hours**

Strings: A String Is a Sequence , len, Traversal with a for Loop, String Slices, Strings Are Immutable, Searching, Looping and Counting- String Methods, The in Operator and String Comparison – **Lists:** A List Is a Sequence, Lists Are Mutable, Traversing a List- List Operations - List Slices - List Methods - Map, Filter, and Reduce - Deleting Elements - Lists and Strings - Objects and Values – Aliasing - List Arguments- **Dictionaries:** Dictionary as a Set of Counters, Looping and Dictionaries, Reverse Lookup, Dictionaries and Lists, Memos, Global Variables, Long Integers.

TUPLES AND FILES **6 Hours**

Tuples: Tuples Are Immutable, Tuple Assignment, Tuples as Return Values, Variable-Length Argument Tuples, Lists and Tuples- Dictionaries and Tuples -Comparing Tuples- Sequences of Sequences- **Files:** Persistence, Reading and Writing, Format Operator, Filenames and Paths, Catching Exceptions, Databases, Pickling and Pipes.

INTRODUCTION TO CLASSES AND OBJECTS **3 Hours**

Classes and Objects: User defined types, Attributes, rectangles and copying- **Classes and Functions:** Time, Pure functions and modifiers- **Classes and Methods:** object oriented features, polymorphism and type based dispatch- **Inheritance:** Card Objects, Class Attributes, Comparing Cards, Inheritance Class Diagrams and Data Encapsulation.

30 Hours

LIST OF EXPERIMENTS

1. Use tuples and lists to assign and hold multiple values.
2. Use lists to manipulate sets of values.
3. Use slices to obtain parts of lists and to manipulate lists.
4. Use range () to generate lists containing sequences of integers.
5. Use for loops to iterate through predefined lists of objects.
6. Use while loops to iterate until satisfactory exit conditions are obtained.
7. Use break to program more flexible loop exit conditions.
8. Read lines of input from the user, without giving a prompt. When the input line is **quit**, stop accepting input. As output, print the input lines in reverse order, one on each output line. The line **quit** should not be included in the output.
9. Write a program to Convert a Decimal number to Binary number

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10. Write a function roots that computes the roots of a quadratic equation. Check for complex roots and print an error message saying that the roots are complex.

Theory: 30Hr **Practical: 15 Hr** **Total Hours: 45**

REFERENCES:

1. Allen B. Downey, “Think Python”, O’Reilly Media, Inc, 2012
2. Mark Lutz, “Learning Python”, "O'Reilly Media, Inc., 5th Edition, 2013.
3. Alex Martelli, “Python in a Nutshell”, "O'Reilly Media, Inc., 2nd Edition 2006.
4. Steven Bird, Ewan Klein and Edward Loper, “Natural Language Processing with Python”, "O'Reilly Media, Inc, 2009.

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U14MCT 602 DESIGN OF MACHINE ELEMENTS

L	T	P	C
3	1	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Recognize the design process and the factors influencing it and design the simple components for static loading

CO2: Estimate the life of the components subjected to varying loads

CO3: Design the circular shafts based on strength and rigidity, keys and couplings for power transmission

CO4: Design the welded joints, threaded joints and springs subjected to static loads

CO5: Select the rolling contact bearings for static and cyclic loads, select the lubricants and bearing dimensions for hydrodynamic lubrication

Pre-requisite

1. U14MET201 Engineering Mechanics
2. U14MCT403 Mechanics of Solids for Mechatronics

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	S								
CO2							S			
CO3		S	W							
CO4		S	M							
CO5		S	S				M			

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

DESIGN PROCESS AND DESIGN FOR STATIC LOAD **9 Hours**

Machine Design - Design Process - Factors influencing design - Calculation of stresses for various load combinations - theories of failure - Factor of safety - Design of curved beams – Crane hook and 'C' frame – Design of levers

DESIGN OF FLUCTUATING LOAD **8 Hours**

Stress concentration - causes & remedies - fluctuating stresses - fatigue failures - S-N curve - endurance limit - notch sensitivity - endurance strength modifying factors - design for finite and

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infinite life - cumulative damage in fatigue failure - Soderberg, Gerber, Goodman, Modified Goodman diagrams - Fatigue design of components under combined stresses

DESIGN OF SHAFTS, KEYS AND COUPLINGS 7 Hours

Shaft design on the basis of strength, torsional rigidity and lateral rigidity and A.S.M.E. code - Design of keys and splines - Design of flange coupling and flexible bushed pin coupling

DESIGN OF JOINTS AND SPRINGS 10 Hours

Threaded fasteners - Bolts of uniform strength - Bolts under tension - Eccentrically loaded bolted joints Welded joints - Welding symbols - Stresses in butt and fillet welds, Design of Welded Joints for static loads - Axially loaded unsymmetrical welded joints, Eccentric load in the plane of welds - theory of bonded joints

Design of springs

Types - applications and materials for springs - Stress and deflection equations for helical compression springs - Style of ends - Design of helical compression and tension springs - Springs in series and parallel – Introduction to Concentric helical springs, Helical torsion Spring, Multi-leaf springs - Surge in springs

ROLLING CONTACT AND SLIDING CONTACT BEARINGS 11 Hours

Types of rolling contact Bearings - Static and dynamic load carrying capacities, Stribeck's Equation, Equivalent bearing load - Load-life relationship - Selection of rolling contact bearings - Design for cyclic loads and speed - mounting of bearings - Types of failure in rolling contact bearings – causes and remedies.

Sliding contact Bearings Lubricating oils: Properties, additives, selection of lubricating oils, Properties & selection of bearing materials - Theory of Hydrodynamic Lubrication, Pressure Development in oil film, Parameters of bearing design, Length to Diameter ratio, Unit bearing Pressure, Radial Clearance, minimum oil film thickness

Theory: 45Hr **Practical: 15 Hr** **Total Hours: 60**

REFERENCES:

1. Bhandari V.B., "Design of Machine Elements", Tata McGraw Hill Publication Co. Ltd.
2. Shigley J.E. and Mischke C.R., "Mechanical Engineering Design", McGraw Hill International 7th Edition, 2003.
3. Prabhu.T.J,"Fundamentals of Machine Design" Bharat Institute or Science and Technology
4. Alfred Hall, Alfred Holowenko, Herman Laughlin, S Somani, "Machine design", Tata McGraw Hill

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U14MCT 603 ROBOTICS ENGINEERING

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Define robotic terminologies and apply the concept of degrees of freedom for a particular robotic configuration.

CO2: Select an appropriate gripper for a given application and also estimate the force components acting on a gripper.

CO3: Develop homogeneous transformation matrices to solve kinematic problems.

CO4: Effectively apply DH notations for direct kinematic problems.

CO5: Calculate the angle of motion at joints for a given end position of a robot.

CO6: Explain various motion planning algorithms.

CO7: Apply Lagrangian and Newton-Euler methods to analyze dynamic characteristics of a RR and RP type planar robots

CO8: Describe various control strategies used in robot control.

CO9: Explain various programming techniques used in industrial robots.

Pre-requisite

1. U14MCT303 Kinematics of Machinery
2. U14MCT301 Sensors and Instrumentation
3. U14MCT505 Industrial Automation

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	M								
CO2		M	S		M					
CO3	S		S							
CO4			S							
CO5	S	S	S							
CO6	M	S	S							
CO7			S							
CO8			S							
CO9					S					

Course Assessment methods:	
Direct	**Indirect**
1. Internal test I 2. Internal test II	Course end survey

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3. Internal test III 4. End semester Examination 5. Assignment	

INTRODUCTION **6 Hours**

Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission - Applications.

FORWARD KINEMATICS **9 Hours**

Rotation matrices - Euler angle and RPY representation - Homogeneous transformation matrices -Denavit- Hartenberg notation - representation of absolute position and orientation in terms of joint parameters - direct kinematics.

INVERSE KINEMATICS AND TRAJECTORY PLANNING **11 Hours**

Inverse Kinematics, inverse orientation, inverse locations, Singularities, Jacobian, Trajectory Planning: joint interpolation, task space interpolation, executing user specified tasks, sensor based motion planning: The Bug Algorithm, The Tangent Bug Algorithm, The Incremental Voronoi Graph.

ROBOT DYNAMICS AND ROBOT CONTROL **11 Hours**

Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangian and Newton-Euler formulations of RR and RP type planar robots, Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, force feedback, hybrid control.

END EFFECTORS **4 Hours**

End effectors and Different types of grippers, vacuum and other methods of gripping - Grippers force analysis-Gripper design-Simple problems

ROBOT PROGRAMMING **4 Hours**

Robot programming: Introduction; On-line programming: Manual input, lead through programming, teach pendant programming; Off-line programming languages, Simulation.

Theory: 45Hr **Total Hours: 45**

REFERENCES:

1. Saeed B. Niku, 'Introduction to Robotics', Prentice Hall of India, 2nd Edition 2010.
2. Mikell P. Groover, "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 2008.
3. Nagrath and Mittal, "Robotics and Control", Tata McGraw-Hill, 2003.
4. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and sons, 2008.
5. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, "Robotics, control, sensing, Vision and Intelligence", McGraw Hill International, 1987
6. Steve LaValle, "Planning Algorithms", Cambridge Univ. Press, New York, 2006.
7. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thurn, "Principles of Robot Motion: Theory, Algorithms, and Implementations", Prentice Hall of India, 2005.

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U14MET604 **THERMODYNAMICS AND HEAT TRANSFER**

L	T	P	C
3	1	0	4

Course Outcomes

After successful completion of this course, the students should be able to

- **CO1:** Define the laws of thermodynamics and describe the properties of the system
- **CO2:** Explain the various air standard cycles and describe the working of I.C engines
- **CO3:** Distinguish various modes of heat transfer and eliminate the rate of heat transfer for various applications
- **CO4:** Discuss the concepts of mass transfer and derive their correlations

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S		S							
CO2			S							
CO3			S				S			
CO4	S		S				S			
CO5										

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

LAWS OF THERMODYNAMICS **9 Hours**

Systems-closed and open systems – properties, processes and cycles - equilibrium - work and heat transfers-first law for a closed system and flow processes - enthalpy - second law – entropy - entropy change - reversibility.

AIR-STANDARD CYCLES **9 Hours**

Air standard cycles: Carnot cycle - Otto cycle - Diesel cycle - Brayton cycle - - cycle efficiency - two stroke and four stroke engines - SI, and CI engines. Case Studies – Application of stand air cycles in Engines.

HEAT TRANSFER : CONDUCTION **9 Hours**

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Basic Concepts - Mechanism of Heat Transfer - Conduction, Convection and Radiation - Fourier Law of Conduction - General Differential equation of Heat Conduction - Cartesian and Cylindrical Coordinates - One Dimensional Steady State Heat Conduction - Conduction through Plane Wall, Cylinders and Spherical systems.

CONVECTION AND RADIATION **9 Hours**

Convection: Basic Concepts – Heat Transfer Coefficients – Boundary Layer Concept – Types of Convection – Forced Convection – External Flow and Internal Flow – Flow over Plates and Cylinders

Radiation: Basic Concepts, Laws of Radiation – Stefan Boltzman Law, Kirchoffs Law – Black Body Radiation – Grey body radiation - Shape Factor Algebra – Electrical Analogy.

MASS TRANSFER **9 Hours**

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

Theory: 45Hr **Tutorial: 15 Hr** **Total Hours: 60**

REFERENCES

1. Rattan S.S, "Theory of Machines'', Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2009.
2. J. J. Uicker, G. R. Pennock and J. E. Shigley, "Theory of Machines and Mechanisms", Oxford University Press, 2003.
3. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 2010.
4. Ghosh A and A. K. Mallick, "Theory of Mechanisms and Machines", 3rd Edition, East West Press Pvt. Ltd, 2009.
5. R. L. Norton, "Kinematics and Dynamics of Machinery", , Tata McGraw Hill, 2009.
6. J. Hannah and R.C. Stephens, "Mechanics of Machines", Viva Low-Prices Student Edition, 1999.

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U14MCP 601 **MINI PROJECT**

L	T	P	C
0	0	4	2

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Design, and realize a simple Mechanical / Electrical / Electronic / Mechatronics system
CO2: Use various sensors, actuators and controllers.
CO3: Work in a team with confined time duration
CO4: Disseminate his work both in oral and written format

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	S	S		S					
CO2			S							
CO3								S		
CO4									S	

Course Assessment methods:	
Direct	**Indirect**
End Semester Viva Voice Interdisciplinary work Publication Working model/ simulation result Innovation Report with good referencing	Course end survey

Students in the form of group not exceeding 3 members in a group to carry out their mini project. It can be a measurement project, Mechatronics project or computer based simulation work. The interdisciplinary projects will carry more weightage. It is highly desirable to publish their project in state/ national level conferences or symposiums.

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U14MC*P* 602 **ROBOTICS LABORATORY**

L	T	P	C
0	0	2	1

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Control mobile robots using different sensors and actuators.

CO2: Manipulate an industrial robot using a machine vision system and HMIs

CO3: Handle a robot model using the robotics simulation software.

CO4: Analyze and present the findings of experimental observations in both written and oral format.

Pre-requisite

1. U14MCT603 – Robotics Engineering

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S		S	M						
CO2	S		M		W					
CO3					S					
CO4				S					S	

Course Assessment methods:	
Direct	**Indirect**
Lab Exercises Model Exam. End Semester Practical Examination Assignment	Course end survey

LIST OF EXPERIMENTS

1 Study of different types of robots based on configuration and application.
2 Study of different type of links and joints used in robots
3 Study of components of robots with drive system and end effectors.
4 Modeling Forward and inverse kinematics for robotic arm using Mathematical Software
5 Offline programming of an Industrial robot using Robotics simulation Software
6 Setup and program a station with conveyor tracking using the Robotics simulation Software
7 Vision-Based Control on an Industrial Robot
8 Writing and verifying a Program for point to point operations for mobile robots
9 Obstacle Avoidance of a mobile robot with Ultrasonic Sensor
10 Tilt sensing for an autonomous mobile robot using accelerometer sensor.
11 Line following robot

Experiments beyond the syllabus should be conducted

Total Hours: 45

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U14ENP 601

COMMUNICATION SKILL LABORATORY

L	T	P	C
0	0	2	1

(Common to all branches of Engineering and Technology)

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Imparting the role of communicative ability as one of the soft skills needed for placement
CO2: Developing communicative ability and soft skills needed for placement
CO3: Making students Industry-Ready through inculcating team-playing capacity

Pre-requisite

1. U14ENT101 / Functional English I
2. U14ENT201 / Functional English II

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				M					S			
CO2				W					S	M		
CO3				S					S	W		

Course Assessment methods:	
Direct	**Indirect**
Lab Exercises Model Exam. End Semester Practical Examination Assignment	Course end survey

GRAMMAR IN COMMUNICATION **9 Hours**

Grammar and Usage – Building Blocks, Homonyms, Subject and Verb Agreement, Error Correction - Grammar Application, Framing Questions – Question words, Verbal Questions, Tags, Giving Replies –Types of Sentences, Listening Comprehension –Listening and Ear training.

ASSERTIVE COMMUNICATION **9 Hours**

Listening Comprehension in Cross–Cultural Ambience, Telephonic Conversations/Etiquette, Role Play Activities, Dramatizing Situations- Extempore – Idioms and Phrases.

CORPORATE COMMUNICATION **9 Hours**

Video Sensitizing, Communicative Courtesy – Interactions – Situational Conversations, Time Management, Stress Management Techniques, Verbal Reasoning, Current Affairs – E Mail Communication / Etiquette.

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PUBLIC SPEAKING **9 Hours**

Giving Seminars and Presentations, Nuances of Addressing a Gathering - one to one/ one to a few/ one to many, Communication Process, Visual Aids & their Preparation, Accent Neutralization, Analyzing the Audience, Nonverbal Communication.

INTERVIEW & GD TECHNIQUES **9 Hours**

Importance of Body Language –Gestures & Postures and Proxemics, Extempore, Facing the Interview Panel, Interview FAQs, Psychometric Tests and Stress Interviews, Introduction to GD, Mock GD Practices.

Total Hours: 45

REFERENCES:

1. Bhatnagar R.P. & Rahul Bhargava, "English for Competitive Examinations", Macmillian Publishers, India, 1989, ISBN: 9780333925591
2. Devadoss K. & Malathy P., "Career Skills for Engineers", National Book Publishers, Chennai, 2013.
3. Aggarwal R.S., "A Modern Approach to Verbal & Non–Verbal Reasoning", S.Chand Publishers, India, 2012, ISBN: 8121905516

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SEMESTER VII

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U14MCT701 INDUSTRIAL AUTOMATION II

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

- **CO1:** Classify the different types of communication protocols
- **CO2:** Explain the importance of SCADA systems
- **CO3:** Summarize the fundamentals of Distributed control systems
- **CO4:** Design power supply, panel disk control for automation.
- **CO5:** Describe various safety related parameters in designing automated system

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1		S	S		S					
CO2					S					
CO3					S	S				
CO4			S				S			
CO5			S			S	S			

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INDUSTRIAL COMMUNICATION PROTOCOLS **9 Hours**

Definition of protocol, Introduction to Open System Interconnection (OSI) model, Communication standard (RS232, RS485), Modbus (ASCII/RTU), Introduction to third party interface, concept of OPC (Object linking and embedding for Process Control), HART Protocol: Introduction, frame structure, programming, implementation examples, benefits, advantages and limitation.

Foundation Fieldbus H1: Introduction, frame structure, programming, implementation examples, benefits, advantages and limitation. Comparison of HART, Foundation Fieldbus, Devicenet, Profibus, Controlnet, Industrial Ethernet.

SCADA SYSTEMS **9 Hours**

SCADA Concept of SCADA systems, Programming techniques for : Creation of pages,

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Sequencing of pages, Creating graphics & animation, Dynamos programming with variables, Trending, Historical data storage & Reporting, Alarm management, reporting of events and parameters, Comparison of different SCADA packages, Interfacing PLC and SCADA using communication link (RS232, RS485) , Protocols (Modbus ASCII/RTU) and OPC, Development stages involved for PLC based automation systems, Application Development using SCADA system.

DISTRIBUTED CONTROL SYSTEMS 9 Hours

DCS introduction, Various function Blocks, DCS components/block diagram, DCS Architecture of different makes, comparison of these architectures with automation pyramid, DCS specification, latest trend and developments, DCS support to Enterprise Resources Planning (ERP), performance criteria for DCS and other automation tools.

DESIGN OF POWER SUPPLY, PANEL AND CONTROL DESK FOR AUTOMATION 9 Hours

Power Supply: Power requirements calculation, Redundancy in Power supply schemes, Choice of Circuit Breakers – Inrush current, Interrogation Power Supply for Inputs / Outputs

Panels and Control Desks: Buffer Termination / Marshalling Cabinets, Power Supply, Distribution in Panels, Control Desks / Panels, PLC/DCS Panels, Earthing – Power, signal and Panel Earthing, Network Cabinets and Racks - Preparation of Wiring Diagrams - Identification and Tagging of cables & instruments - Common wiring practices - Cable schedule and choice of cables.

PROCESS SAFETY AND SAFETY MANAGEMENT SYSTEMS 9 Hours

Introduction to process safety, risk, risk terminologies, consequence and risk, risk measurement, Process Hazard Analysis (PHA), Hazard and operability study (HaZOp), Safety Integrity Level (SIL), Introduction to IEC61511 standard for Functional safety , protection layers, Safety Instrumented System: function, architecture, safety life cycle, Application of safety system.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. John.W.Webb and Ronald A. Reis, "Programmable logic controllers: Principles and Applications", Prentice Hall India, 2003.
2. Michael P. Lukas, "Distributed Control systems", Van Nostrand Reinfold Company, 1995.
3. Frank D. Petruzella, "Programmable Logic Controllers", McGraw-Hill Companies, 3rd Edition, March 2013.
4. Ian G.Warnock, "Programmable Controllers Operation and Application", Prentice Hall International, UK, 1992.
5. Krishnakant , "Computer Based Industrial Control", Prentice Hall of India, 1997.

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U14MC*T*702 AUTOMOTIVE ELECTRONICS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

- **CO1:** Describe the importance of emission standards and electronics in automobiles.
- **CO2:** Identify; select the sensors and actuators used in automobiles for improving fuel economy and also in reduction of emissions.
- **CO3:** Compare the different types of ignition systems, injection systems used in automobiles.
- **CO4:** Explain the different control modes of engine management, networking in vehicles, comfort and safety systems in automobiles

Pre-requisite

1. U14MCT 301 Sensors and Instrumentation
2. U14MC*T* 502 Microcontrollers and Embedded Systems

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1							S			
CO2			S	S			S			
CO3			S							
CO4							S	S		

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION **9 Hours**

Evolution of electronics in automobiles – emission laws – introduction to Euro I, Euro II, Euro III, Euro IV, Euro V standards – Charging systems – working and design of charging circuit diagram – starter motors and starter circuits.limitation.

Foundation Fieldbus H1: Introduction, frame structure, programming, implementation examples, benefits, advantages and limitation. Comparison of HART, Foundation Fieldbus, Devicenet, Profibus, Controlnet, Industrial Ethernet.

BASICS OF ENGINES **9 Hours**

Operating principles of IC engine – major engine components – engine cylinder arrangements – the ignition systems – Electronic ignition, direct ignition, injection systems – working of the

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carburetor – throttle body injection – Multipoint fuel injection – sequential fuel injection.

SENSORS AND ACTUATORS **9 Hours**

Working principle and characteristics of Airflow rate, Engine crankshaft angular position, Hall Effect, Throttle angle, temperature, exhaust gas oxygen sensors – study of fuel injector, exhaust gas recirculation actuators, stepper motor actuator, and vacuum operated actuator.

ENGINE CONTROL SYSTEMS **9 Hours**

Control modes for fuel control-engine control subsystems – ignition control methodologies – different ECU's used in the engine management – block diagram of the engine management system – In vehicle networks: CAN standard, format of CAN standard – diagnostics systems in modern automobiles

CHASSIS, COMFORT AND SAFETY SYSTEMS **9 Hours**

Traction control system – Cruise control system– electronic control of automatic transmission antilock braking system – electronic suspension system –airbag systems – centralized door locking system – Navigation systems – climate control of cars.

CASE STUDY: Design of the Passenger comfort and safety systems.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Tom Denton, "Automobile Electrical and Electronics Systems", Edward Arnold Publishers, 2004.
2. William B. Ribbens, "Understanding Automotive Electronics", Newnes Publishing, 5th edition, 2003
3. Robert Bosch GmbH, "BOSCH Automotive Handbook", Bentley publishers 9th edition, 2014.
4. Barry Hollembeak, "Automotive Electricity, Electronics & Computer Controls", Delmar Publishers, 2001.
5. Warren M. Farnell, "Fuel System and Emission controls", Check Chart Publication, 2000.
6. Ronald. K. Jurgon, "Automotive Electronics Handbook", McGraw-Hill, 1999.

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U14MC*T*703 **MICRO ELECTRO MECHANICAL SYSTEMS**

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Explain the evolution of micro and smart system.
CO2: Illustrate about various sensors and actuating system.
CO3: Classify the Micro machining techniques in MEMS.
CO4: Evaluate a proper scaling method.
CO5: Determine packaging techniques in MEMS and smart system.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S		S					S		S
CO2	S	M	W					S	M	W
CO3		S	S						S	S
CO4	S					W		S		
CO5	S			S				S		

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION **9 Hours**

Overview - Microsystems and microelectronics - definition-MEMS materials-scaling laws scaling in geometry-scaling in rigid body dynamics- scaling in electrostatic forces- scaling in electricity- scaling in fluid mechanics- scaling in heat transfer.

MICRO SENSORS AND ACTUATORS **9 Hours**

Working principle of Microsystems - micro actuation techniques - micro sensors-types –Micro actuators – types – micro pump – micro motors – micro – valves – micro grippers –micro Accelerometers

FABRICATION PROCESS **9 Hours**

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Substrates-single crystal silicon wafer formation-Photolithography-Ion implantation-Diffusion – Oxidation-CVD-Physical vapor deposition-Deposition by epitaxy-etching process.

MICRO SYSTEM MANUFACTURING **9 Hours**

Bulk Micro manufacturing- surface micro machining – LIGA – SLIGA - Micro system packaging-materials - die level-device level-system level-packaging techniques - die preparation - surface bonding -wire bonding - sealing.

MICRO SYSTEM DESIGN **9 Hours**

Design considerations-process design-mask layout design- mechanical design-applications of micro systems in automotive industry, bio medical, aero space and telecommunications.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Tai-Ran Hsu, "MEMS & Microsystems Design and Manufacture", Tata McGraw-Hill, 2006.
2. Mohamed Gad-el-Hak, "The MEMS Hand book", CRC press, 2005.
3. Julian W.Gardner,Vijay K.Varadan,Osama O.Awadel Karim, "Microsensors MEMS and Smart Devices", John Wily & sons Ltd., 2001.
4. S.Fatikow,U.Rembold, "Microsystem Technology and Microrobotics", Springer-Verlag Berlin Heidelberg , 1997.
5. Francis E.H Tay and W.O Choong, "Microfludics and BioMEMS Applications", Springer, 2002.

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U14GS*T* 007 **PROFESSIONAL ETHICS**

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

- **CO1:** Explain the ethical theories and concepts.
- **CO2:** Relate the engineer's work in the context of its impact on society.
- **CO3:** Summarize and analyze the concepts of safety and risk.
- **CO4:** Value the professional responsibilities and rights of Engineers.
- **CO5:** Summarize the concepts of ethics in the global context.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1						S				
CO2						S				
CO3							S			
CO4						S				
CO5						S	S			S

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

ENGINEERING ETHICS AND THEORIES **9 Hours**

Definition, Moral issues, Types of inquiry, Morality and issues of morality, Kohlberg and Gilligan's theories, consensus and controversy, Professional and professionalism, moral reasoning and ethical theories, virtues, professional responsibility, integrity, self respect, duty ethics, ethical rights, self interest, egos, moral obligations.

SOCIAL ETHICS AND ENGINEERING AS SOCIAL EXPERIMENTATION **9 Hours**

Engineering as social experimentation, codes of ethics, Legal aspects of social ethics, the challenger case study, Engineers duty to society and environment.

SAFETY **9 Hours**

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Safety and risk – assessment of safety and risk – risk benefit analysis and reducing risk – the Three Mile Island and Chernobyl case studies. Bhopal gas tragedy.

RESPONSIBILITIES AND RIGHTS OF ENGINEERS **9 Hours**

Collegiality and loyalty – respect for authority – collective bargaining – confidentiality – conflicts of interest – occupational crime – professional rights – employee rights – Intellectual Property Rights (IPR) – discrimination.

GLOBAL ISSUES AND ENGINEERS AS MANAGERS, CONSULTANTS AND LEADERS **9 Hours**

Multinational Corporations – Environmental ethics – computer ethics – weapons development – engineers as managers – consulting engineers – engineers as expert witnesses and advisors – moral leadership – Engineers as trend setters for global values.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering". (2005) McGraw-Hill, New York.
2. John R. Boatright, "Ethics and the Conduct of Business", (2003) Pearson Education, New Delhi.
3. Bhaskar S. "Professional Ethics and Human Values", (2005) Anuradha Agencies, Chennai.
4. Charles D. Fleddermann, "Engineering Ethics", 2004 (Indian Reprint) Pearson Education / Prentice Hall, New Jersey.
5. Charles E. Harris, Michael S. Protchard and Michael J Rabins, "Engineering Ethics – Concepts and cases", (Indian Reprint now available) Wadsworth Thompson Learning, United States, , 2000.

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U14MCP 701	INDUSTRIAL AUTOMATION II LABORATORY AND PROJECTS	L	T	P	C
		0	0	2	1

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Select the suitable communication protocol for the process control applications.
CO2: Use different sensors and actuators to control various industrial parameters: temperature, pressure, level and flow.
CO3: Construct a SCADA HMI screen for the process automation.
CO4: Build a communication network between PLC, HMI and field devices.
CO5: Make use of GSM module to interface with PLC, filed devices and SCADA systems.
CO6: Inspect and control the industrial process using SCADA systems.
CO7: Analyze and present the findings of experimental observations in both written and oral format.

Pre-requisite

1. U14MCT505 Industrial Automation I
2. U14MCT701 Industrial Automation II
3. U14MCP501 Industrial Automation I Laboratory and Projects

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S		M	W	S			S	S	S
CO2	S		S	M		M		S	S	
CO3	S		S		S			S	S	
CO4	S		M		M			S	S	
CO5	S		M		M			S	S	

Course Assessment methods:	
Direct	**Indirect**
Lab Exercises Model Exam. End Semester Practical Examination Assignment	Course end survey

LIST OF EXPERIMENTS

1. Study of industrial process automation and communication network architecture
2. Construct a communication network for process control(HMI, Filed devices)
3. Build a Real time data logging and data processing system

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4. Design to control process parameters such as level, flow, temperature and pressure using closed loop control system
5. Development of SCADA HMI for process automation
6. Test the digital I/O functions using SCADA panel.
7. design a T-junction traffic light controller using SCADA
8. Development of SCADA systems for automating bottle filling systems
9. Development of SCADA systems for Monitoring and control of fluid power systems.
10. Implementation of GSM module to interface with PLC, Field devices and SCADA systems

ADDITIONAL EXPERIMENTS

1. Development of SCADA systems for Monitoring and control of pick and place robot.

Experiments beyond the syllabus should be conducted

Total Hours: 45

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U14MCP 702

EMBEDDED SYSTEM DESIGN LABORATORY

L	T	P	C
0	0	2	1

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Design measurement systems using sensors.
CO2: Develop simple self sustaining embedded system for data logging system.
CO3: Design a system with touch sensitive human machine interface.
CO4: Write standard engineering report and provide focused progress reporting presentations.

Pre-requisite

1. U14MCT405 Digital Electronics And Microprocessor
2. U14MCT502 Microcontrollers And Embedded Systems

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	M	M	W						S
CO2	S	S	M	S						M
CO3	S	S	M	S						M
CO4	S	S	S	M		M				

Course Assessment methods:	
Direct	**Indirect**
Lab Exercises Model Exam. End Semester Practical Examination Assignment	Course end survey

LIST OF EXPERIMENTS

1. Development of hypothetical Switch Protocol using GPIO and timer using ARM7and PSoC3
2. Utilization of capacitive sensing (CapSense) module of PSoC 3 board for simple applications.
3. Implementation of combination Lock with CapSense Swipe.
4. Pulse Width Measurement.
5. Development of simple hand shaking protocol using UART
6. Measurement of Strain using strain gauge.
7. Wireless LED display control system similar to traffic light.
8. Circuit designing and interfacing for IR sensors.
9. Creating the printed circuit pattern on substrate.

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10. Schematic designing of seven segment display.

Experiments beyond the syllabus should be conducted

Total Hours: 45

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U14MC*P* 703 **PROJECT WORK PHASE I**

L	T	P	C
0	0	4	2

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Design, analyze, realize / simulate a physical system by using the technology they learnt during the program.

CO2: Integrate various systems into one Mechatronics product.

CO3: Work in a team with confined time duration.

CO4: Disseminate his work both in oral and written format.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	S	S	M	S	S	M	S	S	S
CO2	S	S	S		S	S	M	S	S	S
CO3								S	S	
CO4	S							S	S	

Course Assessment methods:	
Direct	**Indirect**
End Semester Viva Voice Interdisciplinary work Publication Working model/ simulation result Innovation Report with good referencing	Course end survey

Students in the form of group, not exceeding 3 members in a group to carry out their main project. It should be a Mechatronics project. However, special considerations can be given for interdisciplinary measurement and computer based simulation projects. This exception should be recorded and approved by the department committee. Management related projects will not be allowed. The interdisciplinary projects will carry more weightage. It is mandatory to publish their main project in national/international level conferences to appear in the viva-voce exam.

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SEMESTER VIII

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U14MC*P* 801 **PROJECT WORK PHASE II**

L	T	P	C
0	0	18	9

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Design, analyze, realize / simulate a physical system by using the technology they learnt during the program.

CO2: Integrate various systems into one Mechatronics product.

CO3: Work in a team with confined time duration.

CO4: Disseminate his work both in oral and written format.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	S	S	M	S	S	M	S	S	S
CO2	S	S	S		S	S	M	S	S	S
CO3								S	S	
CO4	S							S	S	

Course Assessment methods:	
Direct	**Indirect**
End Semester Viva Voice Interdisciplinary work Publication Working model/ simulation result Innovation Report with good referencing	Course end survey

Students in the form of group, not exceeding 3 members in a group to carry out their main project. It should be a Mechatronics project. However, special considerations can be given for interdisciplinary measurement and computer based simulation projects. This exception should be recorded and approved by the department committee. Management related projects will not be allowed. The interdisciplinary projects will carry more weightage. It is mandatory to publish their main project in national/international level conferences to appear in the viva-voce exam.

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ELECTIVE I

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U14MC*E* 101 **ENGINEERING ECONOMICS & MANAGEMENT**

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Define the principles of engineering economy followed by basic methods for carrying out economic studies considering the time value of money

CO2: Differentiate between the macro and micro economics

CO3: Explain the various functions of finance and accounting process

CO4: Explain on how to estimate a cost involved in a project

CO5: Explain the various risks that are involved in a project

CO6: Explain and illustrate on how to manage various functions of the project

CO7: Describe on the function of financial systems in India

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1								S		S
CO 2						S			S	
CO 3							S	S	S	
CO 4								S		S
CO 5						S	S			M
CO 6						S				S
CO 7								S		

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

PRINCIPLES OF ENGINEERING ECONOMICS **9 Hours**

Basic principles – Time value of money, Quantifying alternatives for decision making, Cash flow diagrams. Arithmetic gradient, Geometric gradient – Theory of demand and supply – price mechanisms – factors of production – land, labour, capital and organization – National income – Difficulties in estimation – Micro and Macro Economics.

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INTRODUCTION TO FINANCIAL MANAGEMENT AND ACCOUNTING **9 Hours**

Scope & Functions of Finance – Role of Finance Manager – Goals of Financial Management – Profit Maximization Vs. Wealth Maximization – Organization of the Finance Function.

Accounting Principles and Conventions – Double Entry system – Journal, Ledger, Trial Balance and Preparation of Final Account.

PROJECT RISK AND MANAGEMENT **9 Hours**

Project Risk – Sensitivity Analysis – Scenario Analysis – Risk Analysis – Procedure for Developing an NPW Distribution – Expected Value and Variance – Decision Rule.

Engineers, Projects, and Project Management – Project Planning – Project Scheduling – Staffing and Organizing – Team Building – Project Control – Estimating and Contracting.

EQUIPMENT ECONOMICS **9 Hours**

Equipment costs, Ownership and operating costs, Buy/Rent/Lease options, Replacement analysis. Cost estimating: Types of Estimates, Approximate estimates – Unit estimate, Factor estimate, Cost indexes, parametric estimate, and Life cycle cost.

INDIAN FINANCIAL SYSTEM **9 Hours**

Reserve bank of India – Functions – Commercial banking system –Development financial institutions – IDBI –ICICI – SIDBI – IRBI – NABARD– Investment institutions – UTI – Insurance companies – Indian capital market – Stock market – Functions – Role of the public sector – Privatization – Multinational corporations and their impact on the Indian economy.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Agarwal. A. N., "Indian Economy", New Age International Pub. (P) Limited, 1978
2. Michael Jones, "Accounting for Non-Specialists", John Wiley & Sons, 2002
3. Narayanaswamy, R., "Financial Accounting: A Managerial Perspective", Fifth Edition, PHI.
4. Ostwald, P. F., "Construction Cost Analysis and Estimating", Prentice Hall, Upper Saddle River, New Jersey, 2001.

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U14GS*T* 005 TOTAL QUALITY MANAGEMENT

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Distinguish various total Quality Management concepts, principles and the various tools used to implement TQM.

CO2: Apply statistical methods used in industries for quality control.

CO3: Recognize the importance of ISO and Quality system certification process.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1		M				S		S		
CO 2		S		S					S	
CO 3						S		M		S

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION **9 Hours**

Definition of Quality, Dimensions of Quality, Quality costs, Top Management Commitment, Quality Council, Quality Statements, Barriers to TQM Implementation, Contributions of Deming, Juran and Crosby, Team Balancing

TQM PRINCIPLES **9 Hours**

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Continuous Process Improvement,5S, Kaizen, Just-In-Time and TPS

STATISTICAL PROCESS CONTROL **9 Hours**

The seven tools of quality, New seven Management tools, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Concept of six sigma.

TQM TOOLS **9 Hours**

Quality Policy Deployment (QPD), Quality Function Deployment (QFD), Benchmarking, Taguchi Quality Loss Function, Total Productive Maintenance (TPM),

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FMEA

QUALITY SYSTEMS **9 Hours**

Need for ISO 9000 and Other Quality Systems, ISO 9001:2008 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, ISO 14001:2004.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Dale H.Besterfiled, "Total Quality Management", Pearson Education India, 2011.
2. James R.Evans and William M. Lidsay, "The Management and Control of Quality", South-Western (Thomson Learning), 2008.
3. Feigenbaum. A. V. "Total Quality Control", McGraw-Hill Professional, 4th edition, 2004
4. Oakland.J.S. "Total Quality Management", Butterworth – Hcinemann Ltd., Oxford, 2003.
5. Narayana V. and Sreenivasan, N.S. "Quality Management – Concepts and Tasks", New Age International, 2007.
6. Zeiri, "Total Quality Management for Engineers", Wood Head Publishers, 1991.

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+U14MC*E* 102	**FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT**	L	T	P	C
		3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Analyze various global trends and decide on the scope of a new product

CO2: Outline the product development methodologies and management.

CO3: Develop product management plan for a new product based on the type of the new product and development methodology.

CO4: Summarize requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification.

CO5: Conceptualize new product integrating the hardware, software, controls, electronics and mechanical systems.

CO6: Develop test specifications and coordinate the respective activities with testing group, validate the product and confirm its performance as per design specification.

CO7: Develop product documentation as required.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S		S		S					
CO 2		S				S			S	
CO 3		S				S			S	
CO 4		M	S	M						
CO 5	S		S		M	S				
CO 6	S	M		S					S	
CO 7	S								S	S

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

FUNDAMENTALS OF PRODUCT DEVELOPMENT **9 Hours**

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Global Trends Analysis and Product decision: Types of various trends affecting product decision - Social Trends (Demographic, Behavioral, Psychographic), Technical Trends (Technology, Applications, Tools, Methods), Economical Trends (Market, Economy, GDP, Income Levels, Spending Pattern, target cost, TCO), Environmental Trends (Environmental Regulations and Compliance), Political/Policy Trends (Regulations, Political Scenario, IP Trends and Company Policies); PESTLE Analysis

Introduction to Product Development Methodologies and Management: Overview of Products and Services (Consumer product, Industrial product, Specialty products etc); Types of Product Development (NPD/ Re-Engineering (Enhancements, Cost Improvements)/ Reverse Engineering/ Design Porting & Homologation); Overview of Product Development methodologies (Over the Wall/ Waterfall/ V-Model/ Stage-Gate Process/ Spiral/Systems Engineering/ Agile); Product Life Cycle (S- Curve, Reverse Bathtub Curve); Product Development Planning and Management (Budgeting, Risk, Resources and Design Collaboration, Scheduling, Change Management, Product Cost Management).

REQUIREMENTS AND SYSTEM DESIGN 9 Hours

Requirement Engineering: Types of Requirements (Functional, Performance, Physical, Regulatory, Economical, Behavioral, Technical, Stakeholder, Environmental, Industry specific, Internal-Company Specific); Requirement Engineering (Gathering (VOC), Analysis (QFD), Design Specification); Traceability Matrix and Analysis; Requirement Management .

System Design & Modeling: Introduction to System Modeling; System Optimization; System Specification; Sub-System Design; Interface Design.

DESIGN AND TESTING 15 Hours

Conceptualization: Industrial Design and User Interface Design; Introduction to Concept generation Techniques; Concept Screening & Evaluation - Concept Design, S/W Architecture, Hardware Schematics and simulation.

Detailed Design: Component Design and Verification; High Level Design/Low Level Design of S/W Programs, S/W Testing; Hardware Schematic, Component design, Layout and Hardware Testing.

Prototyping: Types of Prototypes (Mockups, Engineering Assessment Prototype, Alpha, Beta, Gama); Introduction to Rapid Prototyping and Rapid Manufacturing.

System Integration, Testing, Certification and Documentation: Manufacturing/Purchase and Assembly of Systems; Integration of Mechanical, Embedded and S/W systems; Introduction to Product verification processes and stages – Industry specific (DFMEA, FEA, CFD); Introduction to Product validation processes and stages - Industry specific (Sub-system Testing/ Integration Testing/ Functional Testing/ Performance Testing / Compliance Testing); Product Testing standards and Certification – Industry specific; Product Documentation (Compliance Documentation, Catalogue, Brochures, user manual, maintenance Manual, Spares Parts List, Warranty, Disposal Guide, IETMS, Web Tools).

SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 6 Hours

Sustenance: Maintenance and Repair; Enhancements.

Product EoL: Obsolescence Management; Configuration Management; EoL Disposal.

BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 6 Hours

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The Industry: Engineering Services Industry – Overview; Product development in Industry versus Academia.

The IPD Essentials: Introduction to vertical specific product development processes; Product development Trade-offs; Intellectual Property Rights and Confidentiality; Security and Configuration management.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. "Foundation Skills in Integrated Product Development (FSIPD)", 1st Edition, Published by NASSCOM, 2013
2. Ulrich, Karl T. and Eppinger, Steven D,"Product Design and Development", 5th Edition, McGraw-Hill, 2012.
3. Kevin N. Otto, "Product design – Techniques in Reverse Engineering and New Product Development", PEARSON, New Delhi, 2011.

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ELECTIVE II

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U14MC*E* 201	COMPUTER INTEGRATED MANUFACTURING	L	T	P	C
		3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Describe the concept of automation and rapid prototyping processes

CO2: Classify the different types of material handling & storage system with principles and applications

CO3: Explain the importance of group technology and cellular manufacturing

CO4: Summarize the fundamentals of flexible manufacturing systems

CO5: Make use of computers to prepare the product and process plan

CO6: Discuss the importance of MRP, Inventory control, JIT and lean manufacturing techniques

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S		M		S	M			S	
CO 2	S		M							S
CO 3	S		M		S				S	
CO 4	S		S	S		S				
CO 5					M				S	S

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION TO AUTOMATION AND PROTOTYPING **9 Hours**

Automation: Introduction, automation principles and strategies, basic elements of advanced functions, levels modeling of manufacturing systems

Definitions, evolution, CAD for RPT, Product design and rapid product development, conceptual design, detail design, prototyping, Fundamentals of RP systems, 3D solid modeling software and their role in RPT, creation of STL file

RAPID PROTOTYPING PROCESSES **5 Hours**

Stereo lithography - Solid Ground Curing - Fusion Deposition Modeling - Laminated Object Manufacturing - Selective Laser sintering -3D Printing

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MATERIAL HANDLING SYSTEMS **6 Hours**

Introduction, material handling systems, principles and design, material transport system: transfer mechanisms automated feed cut of components, performance analysis, uses of various types of handling systems including Automated Guided Vehicles and its various guiding technologies.

STORAGE SYSTEMS **3 Hours**

Performance, location strategies, conventional storage methods and equipment's, automated storage systems.

AUTOMATED MANUFACTURING SYSTEMS **7 Hours**

Components, classification, overview, group technology and cellular manufacturing, parts classification and coding, product flow analysis, cellular manufacturing, application considerations in Group Technology

FLEXIBLE MANUFACTURING SYSTEMS **5 Hours**

Introduction, components, application, benefits, planning and implementation, transfer lines and fundamentals of automated production lines, application.

MANUFACTURING SUPPORT SYSTEMS **10 Hours**

Process planning and concurrent engineering- process planning, CAPP, CE and design for manufacturing, advanced manufacturing planning, production planning and control system, master production schedule, MRP- Capacity planning, shop floor control, inventory control, MRP-II, J.I.T production systems -Lean and agile manufacturing.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. M.P. Groover, Automation, "Production Systems and Computer Integrated manufacturing", 2nd Edition, Pearson Education, 2004.
2. Radhakrishnan P, Subramanyan S, And Raju V., "CAD/CAM/CIM", 2nd Edition New Age International (P) Ltd., New Delhi, 2008.
3. Yoremkoren, "Computer Integrated Manufacturing System", McGraw-Hill, 2007.
4. Pham D.T &Dimov.S.S, "Rapid manufacturing", Springer-Verlag, London, 2011.
5. Chua C.K. et al., "Rapid Prototyping: principles and applications" Wiley, 2003.
6. Zeid I., "CAD/CAM: Theory & Practice", McGraw Hill, Singapore, 1991.

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U14MC*E* 202 ENGINEERING METROLOGY

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Summarize various linear and angular measuring devices used to check dimensions.
CO2: Describe the methods and instruments used in gear & screw parameters measurements.
CO3: Explain the automated systems used in Metrology.
CO4: Choose latest measuring tools for the modern Industrial environment.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	M		M					S	
CO 2	S	M	M							
CO 3	S		M		S				S	
CO 4	S				S					S

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

LINEAR METROLOGY **9 Hours**

Definition of metrology – Linear measuring instrument : Vernier, micrometer measurement, dial indicator, Slip gauges and classification, interferometer, optical flats - limit gauges, Comparators - Mechanical, pneumatic, optical and electric types, applications

ANGULAR METROLOGY **5 Hours**

Sine bar, Vernier bevel protractor, optical bevel protractor, auto collimator, angle gauges, Clinometer, angle Decker – taper measurements.

SCREW THREAD AND GEAR METROLOGY **6 Hours**

Screw thread terminology – Measurement of various elements of Thread - Measurement of Major and minor diameter - Measurement of Thread angle by Two Ball Method - Pitch Measurement. Types of Gear-Gear Terminology-Spur gear measurement -Run out ,Pitch ,Concentricity ,profile ,lead ,alignment ,Back lash- Chordal thickness Method-Constant chord method-Parkinson gear tester.

SURFACE MEASUREMENT **3 Hours**

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Surface evaluation, Stylus method, Numerical values for surface assessment, Surface texture specimens, straightness, flatness and roundness measurement.

ADVANCED TECHNIQUES IN METROLOGY **7 Hours**

Coordinate measuring machine – constructional features – types and application, digital devices – computer aided inspection — machine vision systems, Profile projector, Universal Measuring Machine, Laser principles – Laser interferometer – application in linear, angular measurement and machine tool metrology.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Jain. R K "Engineering Metrology" Khanna Publishers, 2009.
2. Manohar Mahajan, "A textbook of Metrology", Dhanpat Rai & Co (P) LTD., 2008.
3. Alan S. Morris "The Essence of Measurement" Prentice Hall of India, 1997.
4. Connie Dotson, Ronger Harlow and Richard L Thomson, "Fundamentals of Dimensional Metrology", Thompson – Delmar, 4th edition, 2006.
5. Gupta S C, "Engineering Metrology", Dhanpat Rai Publications, 2005.

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U14MC*E* 203 MACHINE VISION SYSTEMS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Summarize acquisition and processing methods of digital image along with their applications

CO2: Design filters for image enhancement.

CO3: Compare image enhancement in spatial domain with frequency domain

CO4: Choose appropriate image compression and segmentation techniques for different applications

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S									
CO2		S		S						
CO3		S								
CO4							S			S

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION **7 Hours**

Digital image representation; fundamental steps in image processing; elements of digital image processing systems: image acquisition: Vision System: Basic Components – Elements of visual perception, Lenses: Pinhole cameras, Gaussian Optics – Cameras – Camera-Computer interfaces, storage, processing and display.

DIGITAL IMAGE FUNDAMENTALS **6 Hours**

Structure of the human eye; image formation; brightness adaptation and discrimination; a simple image model; uniform and non-uniform sampling and quantization; some basic relationships between pixels; neighbors of a pixel; Connectivity; Labeling. Distance measures; imaging geometry.

IMAGE ENHANCEMENT IN THE SPATIAL DOMAIN **9 Hours**

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Basic gray level transformations-histogram processing-Enhancement using arithmetic/logic operations-Basics of spatial filtering-comparison between smoothing and sharpening spatial filters.

IMAGE ENHANCEMENT IN THE FREQUENCY DOMAIN **9 Hours**

1D Fourier transform-2D Fourier transform and its Inverse-Smoothing & sharpening.
Frequency domain filters (Ideal, Butterworth, Gaussian)-homomorphic filtering.

MACHINE VISION **7 Hours**

Segmentation – Thresholding, Edge detection and Region growing. Binary Morphology and grey morphology operations. Feature Extraction, Object recognition, Depth measurement.

APPLICATIONS **7 Hours**

Transforming sensor reading, Mapping Sonar Data, Aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatiograms, K-means Clustering, EM Clustering.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Ramesh Jam, Rangachari Kasturi, Brain G. Schunck, "Machine Vision", Tata McGraw-Hill, 1991.
2. P.A. Janaki Raman, "Robotics and Image Processing", Tata McGraw-Hill, 1991.
3. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Pearson Education Asia/Addison Wesley publishing company, 6th Indian Reprint,2008.
4. Anil K. Jain, "Fundamentals of Digital Image Processing", Prentice-Hall of India, New Delhi, 2001.
5. Maher A. Sid-Ahmed, "Image Processing Theory, Algorithms and architectures", McGraw-Hill, 1995.
6. William K. Pratt, "Digital Image Processing", Wiley-Inter Science Publication, 2nd Edition, 1991.
7. Arthur K Wreeks, "Fundamentals of Electronics Image Processing", Prentice-Hall of India, New Delhi, 2001.

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ELECTIVE III

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U14MCE 301 MODELLING AND SIMULATION

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Define the simulation and its importance in creation of models for real time systems.
CO2: Describe the different types of systems.
CO3: Simulate the real time systems by generating the random numbers and variables.
CO4: Design and analyze the model using simulation software packages.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S			S					S	
CO 2	S								S	M
CO 3	S	M		S						
CO 4			M	S	S				M	

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

SYSTEM AND SYSTEM ENVIRONMENT **9 Hours**

Component of a System – Continuous and discrete systems – Types of model; Steps in Simulation study; Simulation of an event occurrence using random number table – Single server queue –two server queue – inventory system.

RANDOM NUMBER GENERATION **9 Hours**

Properties of random numbers – Generation of Pseudo – random numbers – techniques of generating pseudo random numbers; Test for random numbers: the Chisquare test-the kolmogrov Smirnov test – Runs test – Gap test – poker test.

RANDOM – VARIATE GENERATION **9 Hours**

Inverse transform technique for Exponential, Uniform, triangular, weibull, Empirical, Uniform and discrete distribution, Acceptance rejection method for Poisson and gamma distribution, Direct Transformation for normal distribution.

ANALYSIS AND EVALUATION OF MODEL **9 Hours**

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Data collection, identifying the distribution, Parameter estimation, goodness of fit tests, verification and validation of simulation models.

SIMULATION SOFTWARE PACKAGES **9 Hours**

Comparison and selection of General Purpose Simulation System (GPSS), SIMSCRIPT, SLAM, Arena simulation language, Modeling basic operations using Arena – An Electronic Assembly and testing system, Development of simulation models using Arena simulation package for queuing system, Production system, inventory system, Arena Integration and customization. Simulation Case Study of a Metal-Parts Manufacturing Facility.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Banks J., Carson J.S. and Nelson B.L., "Discrete – Event System Simulation", Pearson Education, Inc 3rd Edition, 2005.
2. David Kelton.W, and Randall P. Sowdowski, "Simulation with Arena", McGraw Hill, 2nd Edition, 2002.
3. Geoffrey Gorden, "System Simulation", Prentice Hall of India, 2003.
4. Narsingh Deo., "System Simulation with Digital Computer", Prentice Hall of India, 2003.

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U14MCE 302 STATISTICAL QUALITY CONTROL

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Define the concept of probability, and also the various sampling method to measure quality and the attributes of quality.

CO2: Summarize the process behavior based on various control charts.

CO3: Select the appropriate samples for the study.

CO4: Apply various techniques to improve the overall quality.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	S		M					S	
CO 2	S			M					S	
CO 3	S	M		S						
CO 4	S				S	M				S

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION **9 Hours**

Probability concepts, Review of distribution: Normal, Poison's, and Binomial, Problems, Measuring of quality and control, Value and quality, Quality costs, Quality assurance.

CONTROL CHARTS FOR VARIABLES **9 Hours**

Chance and assignable causes of quality variation, Control charts for variables, X-bar, R, and σ-charts, Warning and modified control limits, Process capability study, Ranges, Moving Averages, and Six σ- limits, multivariate charts.

CONTROL CHARTS FOR ATTRIBUTES **9 Hours**

Limitation of variable chart, p-chart, problems with variable sample size, np-chart, c- chart, u-chart, and ku-chart, Demerits per unit control chart.

ACCEPTANCE SAMPLING **9 Hours**

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Economics of sampling, Lot formation, OC-Curve-Producer's and Consumer's risk, Single and double sampling plans, AOQ, AOQL, ATI, ASN, Sequential sampling plan, MIL – STD – 1050 tables, MIL – STD – 414 tables, IS 2500 Standard.

QUALITY IMPROVEMENT **9 Hours**

Zero defects program, Quality circle, Fishbone diagram, scatter diagram, Pareto Analysis, Deming cycle, Introduction to Reliability function, System reliability of series, parallel, and combined configurations, Reliability improvement techniques.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Grant E.L. and Leavensworth, "Statistical Quality Control", Tata McGraw-Hill Publishing Company, 5th edition 2002.
2. Douglas C. Montgomery, "Statistical Quality Control", John Wiley and Sons, 2001.
3. Fiegenbaum, A.V., "Total Quality Control", McGraw-Hill Inc., 1991.
4. Sharma S.C., "Inspection Quality Control and Reliability", Khanna Publishers, New Delhi, 1998
5. Srinath L.S "Reliability Engineering", Affiliated East west Press, 1998.

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U14GST 006

PROBABILITY AND APPLIED STATISTICS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Compute measures of central tendencies, dispersions and correlate the variables.

CO2: Analyze random or unpredictable experiments and investigate important features of random experiments.

CO3: Construct probabilistic models for observed phenomena through distributions which play an important role in many engineering applications.

CO4: Analyze sample data and interpret the same for population.

CO5: Sketch the control charts and outline the process capability.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	S		S						
CO 2	S	M		S	M					
CO 3	S	M	M						S	S
CO 4	S			S					S	
CO 5	S			S					S	

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

STATISTICAL MEASURES 9 Hours

Measures of central tendency: Mean Median and Mode – Measures of variation – Range, standard deviation, Mean deviation and coefficient of variation. Correlation and Regression: Karl Pearson's coefficient of correlation –Rank Correlation – Regression lines (Definitions and simple numerical problems only)..

PROBABILITY AND RANDOM VARIABLE 10 Hours

Axioms of probability - Conditional probability - Total probability – Baye's theorem - Random variable - Probability mass function - Probability density function- moments –moment generating

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function- properties.

STANDARD DISTRIBUTIONS **8 Hours**

Binomial, Poisson and Normal distributions – properties- Fitting of Binomial, Poisson and normal distributions to data.

TESTING OF HYPOTHESIS **9 Hours**

Testing of hypothesis for large samples (single mean, difference of means, single proportion, difference of proportions) – Small samples tests based on t and F distributions (single mean, difference of means, paired *t*- test and variance ratio test) – Chi-square test for independence and goodness of fit - Simple numerical problems only.

DESIGN OF EXPERIMENTS AND QUALITY CONTROL **9 Hours**

Analysis of variance – One way classification - Two – way classification – CRD - RBD - Latin square – LSD Concept of process control - Control charts for variables – $\overline{X}$, R – charts – Control charts for attributes – p, np, c – charts – Tolerance limits.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Veerarajan T., "Probability and Statistics", Tata McGraw-Hill, New Delhi, 2007.
2. Gupta S. P., "Statistical Methods", Sultan Chand & Sons Publishers, 2004.
3. Johnson R. A., "Miller & Freund's Probability and Statistics for Engineers", Pearson Education, Delhi, 6th Edition, 2000.
4. Gupta S.C. and Kapur J.N., "Fundamentals of Mathematical Statistics", Sultan Chand, New Delhi, 9th Edition, 1996.
5. Walpole R. E., Myers S.L. & Keying Ye, "Probability and Statistics for Engineers and Scientists", Pearson Education Inc, 2002.
6. Arunachalam T., "Probability and Statistics", Inder Publications, Coimbatore, 2008.

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ELECTIVE IV

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U14MC*E* 401

FINITE ELEMENT ANALYSIS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Develop the governing equations for a continuum.
CO2: Model and assemble the stiffness matrices for 1D, 2D elements.
CO3: Choose the appropriate element type for a particular application.
CO4: Apply the FEM for plate bending and thermal analysis.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	S							S	
CO 2	S	S	M							
CO 3	S		S		S					
CO 4	S		S			S				

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION **9 Hours**

Historical background – Introduction to FEA – Review of Matrix Algebra and Gaussian elimination – Governing equations for continuum – Spring assemblage – Stiffness method & Potential Energy Approach – Galerkin's weighted residual method

ONE DIMENSIONAL ELEMENTS – BAR, PLANE TRUSS & BEAM **9 Hours**

Bar element - Stiffness Matrix in local and global coordinates, Computation of Stress – Potential Energy and Galerkin's residual method – Solution of Plane Truss – Beam element – Stiffness and assembly of stiffness matrices - Potential energy and Galerkin's approach

PLANE STRESS & PLANE STRAIN – CST & LST APPROACH **8 Hours**

Binomial, Poisson and Normal distributions – properties- Fitting of Binomial, Poisson and normal distributions to data

AXISYMMETRIC ELEMENTS AND ISOPARAMETRIC FORMULATION **10 Hours**

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Axisymmetric formulation – Stiffness Matrix – Pressure Vessel Analysis – Applications – Isoparametric formulation – Formulation for Bar and Plane Elements – Numerical Integration – Gaussian & Newton-Cotes Quadrature – Evaluation of Stiffness Matrix by Gaussian Quadrature..

PLATE BENDING AND THERMAL ANALYSIS **9 Hours**

Basic Concepts of Plate Bending – Element Stiffness Matrix and Equations – Heat Transfer – Basic Differential Equation and Units – 1d and 2d formulation

CASE STUDY: Finite Element Analysis on Bicycle Frame, Finite Element Analysis on V-belt pulley of a fodder crushing machine

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Daryl, L. Logan, "A First course in the Finite Element Method", Thomson Learning, 4th edition, 2007.
2. Chandrupatla T.R., and Belegundu A.D.,"Introduction to Finite Elements in Engineering", Pearson Education, 3rd Edition, 2002.
3. David V Hutton "Fundamentals of Finite Element Analysis", McGraw-Hill International Edition, 2004.
4. Rao S.S., "The Finite Element Method in Engineering", Pergammon Press, 1989.
5. J. N. Reddy, "An Introduction to the Finite Element Method", Tata McGraw Hill, 3rd Edition, 2005.

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U14MC*E* 402

GEOMETRIC DIMENSIONING AND TOLERANCES

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Interpret and apply geometric dimensioning and tolerance to engineering drawings.

CO2: Assess various datum schemes against product functionality and manufacturing and inspection performance.

CO3: Choose appropriate fits, tolerance with economically.

CO4: Relate common gauging and inspection methods to geometric tolerance zones and feature control frames.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S									
CO 2				M						M
CO 3		M		M						
CO 4		M								W

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

CONCEPTS OF ACCURACY 9 Hours

Introduction-Concepts of Accuracy of Machine Tools-Spindle and Displacement Accuracies-Accuracy of Numerical Control Systems-Errors due to Numerical Interpolation Displacement Measurement System and Velocity Lags. Indian standard Institution system – British standard system, International Standard system.

GOEMETRIC DIMENSIONING AND TOLERANCING 9 Hours

Introduction, normal size, tolerance limits, deviations, allowance, fits and their types-Surfaces, Features of Size, Datum features-Datum Oddly Configured and Curved Surfaces as Datum Features, Equalizing Datums-Datum Feature of Representation-Form Controls, Orientation Controls-Logical Approach to Tolerancing.

DATUM SYSTEMS 9 Hours

Design of Freedom, Grouped Datum systems-Different types, Two and Three mutually

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perpendicular grouped datum planes, Grouped Datum System with spigot and recess, pin and hole, Grouped Datum System with spigot and recess pair and Tongue-Slot Pair-Computation of Transnational and Rotational accuracy, Geometric Analysis and Application.

TOLERANCE ANALYSIS **9 Hours**

Process Capability, Mean, Variance, Skewness, Kurtosis, Process Capability Metrics, Cp, Cpk, Cost Aspects, Feature Tolerances, Geometric Tolerances. Surface Finish, Review of relationship between attainable tolerance grades and different Machining Process. Cumulative effect of Tolerances sure fit law, normal law and truncated normal law.

TOLERANCE CHARTING TECHNIQUES **9 Hours**

Operation Sequence for typical shaft type of components, Preparation of Process drawings for different Operations, Tolerance Worksheets and centrally analysis, Examples. Design features to facilitate Machining: Datum Features-functional and Manufacturing. Components design-Machining considerations, Redesign for Manufactured Examples.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Murthy R.L., "Precision Engineering in Manufacturing", New Age International (p) Limited, 1996.
2. James D. Meadows, "Geometric Dimensioning and Tolerancing", Marcel Dekker Inc. 1995.
3. David Dorifield, DaeEur Lee, "Precision Manufacturing", Springer Publishers, 2008.
4. BIS standards on Limits & Fits, Surface Finish, Machine Tool Alignment etc.

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U14MC*E* 403

DESIGN OF MATERIAL HANDLING SYSTEMS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Recognize the need and types of the Material Handling Equipments
CO2: Calculate the power requirements and select the components for the belt conveyors
CO3: Select and design the conveyors for the particular application
CO4: Differentiate the conveyors and elevators and design the bucket and cage elevators

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S									
CO 2				M						M
CO 3		M		M						
CO 4		M								W

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

MATERIAL HANDLING EQUIPMENTS (MHE) **4 Hours**

Materials and Bulk materials – Types of material handling equipments – selection and applications of MHE.

BELT CONVEYORS **12 Hours**

General components of belt conveyors - Selection of belt speed and belt width – Drive unit design: Power requirement – coupling types and selection – Speed reduction: gearbox types and selection – Shaft and Pulley design – selection of Idlers and Idlers spacing – Safety devises for belt conveyors

DESIGN OF OTHER CONVEYORS **10 Hours**

Apron conveyors, Screw conveyors, Cleat conveyors and Pneumatic conveyors

ELEVATORS **11 Hours**

Conveyors and Elevators – Bucket elevators: centrifugal type and continuous type bucket elevators – Design of bucket elevators – Safety devices for bucket elevators

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Cage elevators: Shaft way, guides, counter weights – safety devises

HOISTS **10 Hours**

Design of Hoisting elements: Welded and roller chains – Hemp wire and ropes – Design of ropes – Pulley – sprockets and drums

Load handling attachments – Forged and Eye hooks – crane grabs – lifting magnets – Grabbing attachments – arresting gears and brakes

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Rudenko N., "Materials handling equipment", ELnvee Publishers, 1970.
2. Fenner & Dunlop, "Conveyor Handbook"
3. Indian standard, "11592:2000 Selection and Design of belt conveyors code of practice", 1981.

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ELECTIVE V

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U14MC*E* 501 ARTIFICIAL INTELLIGENCE

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Explain the characteristics of AI systems with different searching techniques and algorithms.

CO2: Develop algorithms to train the system in playing games.

CO3: Summarize the concepts of knowledge representation.

CO4: Build a simple AI System.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	S							S	
CO 2	S		S		S					
CO 3	S	M							S	
CO 4	S		S		S					S

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION **9 Hours**

Definition – Pattern recognition – Criteria of success – Production Systems – Control Strategies – Heuristic Search – Problem Characteristics – Production System Characteristics – Forward and backward reasoning – Matching Indexing – Heuristic Functions, Search algorithms.

GAME PLANNING **8 Hours**

Overview – Minimax search procedure – Adding Alpha – Beta cutoffs – Waiting for Ouiescence – Secondary search – Using book moves.

KNOWLEDGE REPRESENTATION USING CONVENTIONAL LOGICS **10 Hours**

Use of Predicate logic – Introduction to representation – representing simple facts in logic augmenting the representation – resolution – Conversion to clause from – The basis of resolution Unification of algorithm – ~~Question answering – Natural Deduction.~~

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KNOWLEDGE REPRESENTATION USING MODERN LOGICS **8 Hours**

Nonmonotonic reasoning – Statistical Probabilistic reasoning – Techniques for dealing with a random world and deterministic world – rule based system.

STRUCTURAL REPRESENTATIONS OF KNOWLEDGE **9 Hours**

Common knowledge structures – level of representation – Right structures – Declarative representations – Semantic nets – Conceptual dependency Frames Scripts – Procedural representation – Natural language understanding – Perception – learning – Implementation A.I. Systems.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Elaine Rich, "Artificial Intelligence", McGraw-Hill Book Co., 2009.
2. M. W. Richaugh, "Artificial Intelligence, A. Knowledge Based Approach", PWS Rent Publishing Boston, 1998.
3. Charniac. E and M.C.Dermott. "Introduction to Artificial Intelligence", Addison Wesley Publishing Company, 2002.
4. Robert Goodell Brown, "Materials Management Systems – A Members Library", John Wiley Publishers, 1977.
5. Westing Fine and Zone, "Purchasing Management Principles", John Wiley Publishers, 1986.

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U14MC*E* 502 TEXTILE MECHATRONICS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Explain the evolution of textile technology and manufacturing with textile fibers

CO2: Describe various process and machines involved in spinning

CO3: Explain various process and machines involved in weaving

CO4: Explain various stages of automation scopes in spinning and weaving

CO5: Explain role of computers in automated textile manufacturing

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1			S				W			
CO2					S	S				
CO3					S	S				
CO4					S	S	S			
CO5			S							
CO6			S		S					

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION TO TEXTILE TECHNOLOGY **4 Hours**

History of textile technology and its advancements, introduction to textile fibers, overview of textile manufacturing, Introduction to automation in textile industries.

BASICS OF SPINNING **8 Hours**

Spinning process flow chart – Objectives and process variables of textile spinning machineries: Mixing, Blow room, Carding, Draw frame, Combing, Speed frame, Ring frame, rotor spinning.

BASICS OF WEAVING **8 Hours**

Weaving process flowchart – Objectives and process variables in weaving preparatory: Winding, Warping, Sizing and beaming. Objectives and process variables in weaving: drawing in,

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knotting, denting and weaving.

BASICS OF PROCESSING **5 Hours**

Objectives and process variables in processing machines: Singeing, Desizing, Scouring, Bleaching, Mercerizing, Dyeing, Printing, Finishing.

AUTOMATION IN SPINNING MACHINERY **8 Hours**

Machinery material flow and its variation controls – Feeders & Stop motions – Auto levelers – Safety switches – Production and quality monitors – Full doff and pre-set length monitors. Data acquisition system for spinning preparatory, ring spinning – rotor spinning.

AUTOMATION IN WEAVING MACHINERY **8 Hours**

Yarn cleaner controls – Knotter / splicer carriage controls – Warping machine monitors and controls – sizing machine monitors and controls – Auto reaching / drawing in and knotting machine monitors and controls – Data acquisition system in weaving preparatory and weaving – humidification systems .

APPLICATIONS **4 Hours**

CAD / CAM / CIM in spinning, Weaving, Dyeing, Printing, Apparel production – Electronics data interchange - Robotics in textile industries

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Chattopadhyay R. (Ed), "Advances in Technology of Yarn Production", NCUTE, IIT Delhi, 2002.
2. Oxtoby E "Spun Yarn Technology" butter worth's, London, New Edition 2002.
3. Lord P.R. and Mohammed M.H., "Weaving – Conversion of Yarn to Fabric", Merrow Publication, 2001.
1. Krishna Kant, "Computer – Based Industrial Control", PHI Learning Pvt Ltd, 2nd edition, New Delhi, 2011.
2. Venkatachalam. A and Ashok Kumar L, "Monograph on ― Instrumentation & Textile Control Engineering" – 2005.
3. Berkstresser G A, Buchanan D R and Grady P, "Automation in the Textile Industry from Fibers to Apparel", The Textile Institute, UK, 1995.
4. "Textiles Go On-line", the textile Institute, UK, 1996.
5. Nalura B C. "Theory and Applications of Automation Controls" New Age International (P) Ltd Pub, 1998.
6. Ormerod A, "Modern Development in spinning and Weaving Machinery", Butterworth's, 1993.

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U14MCE503 MEDICAL MECHATRONICS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Explain different measurement techniques used in physiological parameters measurement.

CO2: Describe the sensors and signal conditioning circuits used in biomedical engineering.

CO3: Comment on various measurement systems used in diagnostics.

CO4: Differentiate the working of recorders and explain the advanced systems used in medicine.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S			S						
CO2			S	S						
CO3				S		S				
CO4			S							
CO5					S					

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION **9 Hours**

Cell structure – electrode – electrolyte interface, electrode potential, resting and action potential , source of bioelectric potentials – electrodes for their measurement, ECG, EEG, EMG – machine description – methods of measurement – three equipment failures and trouble shooting.

BIO-MEDICAL SENSORS AND TRANSDUCERS **9 Hours**

Basic transducer principles Types — resistive, inductive, capacitive, fiber-optic, photoelectric, chemical, active and passive transducers and their description and feature applicable for

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biomedical instrumentation – Bio, Nano sensors and application.

SIGNAL CONDITIONING AND DISPLAY 9 Hours

Input isolation, DC amplifier, instrumentation, charge amplifier, power amplifier, and differential amplifier – feedback, op-Amp-electrometer amplifier, carrier Amplifier – instrument power supply, basis of signal conversion and digital filtering, data reduction technique – time and frequency domain technique.

MEDICAL MEASUREMENT AND MONITORING SYSTEMS 9 Hours

Blood pressure measurement: by ultrasonic method – plethysonography – blood flow measurement by electromagnetic flow meter, cardiac output measurement by dilution method – phonocardiography – vector cardiography. Heart lung machine – artificial ventilator – Anesthetic machine – Basic ideas of CT scanner – MRI and ultrasonic scanner – cardiac pacemaker –defibrillator patient safety - electrical shock hazards - Centralized patient monitoring system.

RECORDERS AND ADVANCED SYSTEMS 9 Hours

Oscillagraphic – galvanometric - thermal array recorder, photographic recorder, storage oscilloscopes, electron microscope.Biotelemetry, Diathermy,Audiometers, Dialysers, Lithotripsy. **CASE STUDIES: Hot wire Anemometry for respiratory flow measurements.**

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Khandpur, R.S., “Handbook of Biomedical Instrumentation”, TMH, 2009
2. Cromwell, Weibell and Pfeiffer, “Biomedical Instrumentation and Measurements”, Prentice Hall of India, 2nd Edition, 2007.
3. Geddes L.A., and Baker, L.E., “Principles of Applied Bio-medical Instrumentation”, , John Wiley and Sons, 3rd Edition, 1995.
4. Tompkins W.J., “Biomedical Digital Signal Processing”, Prentice Hall of India, 1998.
5. M.Arumugam, „Bio-Medical Instrumentation“, Anuradha Agencies, 2003.

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U14MCE504 **SOFT COMPUTING**

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Implement numerical methods in soft computing.
CO2: Explain the fuzzy set theory.
CO3: Discuss the supervised and unsupervised learning networks
CO4: Summarize on neuro fuzzy modeling
CO5: Demonstrate some applications of computational intelligence

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	S			M					
CO2	S	M							S	
CO3	S	M		S						
CO4	S	M							S	
CO5	S	S	M		M					

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

FUZZY SET THEORY **10 Hours**

Introduction to Neuro – Fuzzy and Soft Computing – Fuzzy Sets – Basic Definition and Terminology – Set-theoretic Operations – Member Function Formulation and Parameterization – Fuzzy Rules and Fuzzy Reasoning – Extension Principle and Fuzzy Relations – Fuzzy If-Then Rules – Fuzzy Reasoning – Fuzzy Inference Systems – Mamdani Fuzzy Models – Sugeno Fuzzy Models – Tsukamoto Fuzzy Models – Input Space Partitioning and Fuzzy Modeling.

OPTIMIZATION **8 Hours**

Derivative-based Optimization – Descent Methods – The Method of Steepest Descent – Classical Newton's Method – Step Size Determination – Derivative-free Optimization – Genetic

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Algorithms – Simulated Annealing – Random Search – Downhill Simplex Search.

NEURAL NETWORKS 10 Hours

Supervised Learning Neural Networks – Perceptrons - Adaline – Backpropagation Mutilayer Perceptrons – Radial Basis Function Networks – Unsupervised Learning Neural Networks – Competitive Learning Networks – Kohonen Self-Organizing Networks – Learning Vector Quantization – Hebbian Learning.

NEURO FUZZY MODELING 9 Hours

Adaptive Neuro-Fuzzy Inference Systems – Architecture – Hybrid Learning Algorithm – Learning Methods that Cross-fertilize ANFIS and RBFN – Coactive Neuro Fuzzy Modeling – Framework Neuron Functions for Adaptive Networks – Neuro Fuzzy Spectrum.

APPLICATIONS OF COMPUTATIONAL INTELLIGENCE 8 Hours

Printed Character Recognition – Inverse Kinematics Problems – Automobile Fuel Efficiency Prediction – Soft Computing for Color Recipe Prediction.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI, 2004, Pearson Education 2004.
2. Timothy J.Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill, 1997.
3. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
4. S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2003.
5. R.Eberhart, P.Simpson and R.Dobbins, "Computational Intelligence - PC Tools", AP Professional, Boston, 1996.Cromwell, Weibell and Pfeiffer, "Biomedical Instrumentation and Measurements", Prentice Hall of India, 2nd Edition, 2007.

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ELECTIVE VI

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U14MC*E* 601 RENEWABLE ENERGY SOURCES

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Discuss on the available solar energy and the current solar energy collectors and utilization processes.

CO2: Identify available wind energy resources and techniques to utilize them effectively.

CO3: Describe on biomass, waste preparation and utilization technologies and assess the competitiveness of these technologies under different scenarios.

CO4: Summarize the significance of hydrogen and fuel cells principles, storage and uses.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	S							S	
CO2	S	M	M							M
CO3	S					S			S	
CO4	S								S	S

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

SOLAR ENERGY **9 Hours**

Sun as Source of Energy, Availability of Solar Energy, Nature of Solar Energy, Solar Energy & Environment. Various Methods of using solar energy – Photothermal, Photovoltaic, Photosynthesis, Present & Future Scope of Solar energy.

Solar collectors- types of collectors - characteristics and design principles of different type of collectors, performance and testing of collectors - Solar water and air heaters - performance and applications- solar cooling - solar drying - solar ponds - solar tower concept - solar furnace.

WIND ENERGY **9 Hours**

Basics & Power Analysis, Wind resource assessment, Power Conversion Technologies and applications, Wind Power estimation techniques, Principles of Aerodynamics of wind turbine

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blade, Various aspects of wind turbine design.

Wind Turbine Generators: Induction, Synchronous machine, constant V & F and variable V & F generations, Reactive power compensation. Site Selection, Concept of wind form & project cycle, Cost economics & viability of wind farm.

BIO-ENERGY **6 Hours**

Photosynthesis process, Bio-fuels, Biomass resources Bio based chemicals and materials Thermo-chemical Conversion: Pyrolysis, Combustion, Gasification, Liquification. Bio-Chemical Conversion: Aerobic and Anaerobic conversion, Fermentation etc.

BIOMASS **9 Hours**

Generation and utilization, Properties of biomass, Agriculture Crop & Forestry residues used as fuels. Biochemical and Thermo-chemical Conversion, Combustion, Gasification, Biomass gasifiers and types etc. Applications of Gasifiers to thermal power and Engines, Biomass as a decentralized power generation source for villages.

HYDROGEN ENERGY **9 Hours**

Hydrogen as a renewable energy source, Sources of Hydrogen, Fuel for Vehicles.

Hydrogen Production: Direct electrolysis of water, thermal decomposition of water, biological and biochemical methods of hydrogen production.

Storage of Hydrogen: Gaseous, Cryogenic and Metal hydride.

FUEL CELL **3 Hours**

Fuel cell – Principle of working, construction and applications.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Sukhatme, S.P., "Solar Energy, Principles of Thermal Collection and Storage", 3rd Edition, Tata MCGraw Hill, 2008.
2. B.H.Khan, "Non Convention Energy Resources", 2nd Edition, Tata McGraw Hill, 2009.
3. S.RAO and Parul ehar, "Energy Technology – Non conventional, Renewable and Conventional ", 3rd Edition (6th Reprint), Khanna Publishers, 2009.
4. Garg.H. P and Prakash. J., "Solar Energy - Fundamentals and applications", 21st revised edition, Tata McGraw Hill, 2000.
5. Freris L.L., "Wind energy Conversion Systems", Prentice Hall, 1990.
6. Rai G.D, "Non conventional Energy sources" 4th edition (24th Reprint), Khanna Publishers, New Delhi, 2009.
7. George W Sutton-(Editor), "Direct Energy Conversion", Lathur University, Electronic Series Vol 3, McGraw Hill, 2002.

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U14MC*E* 602 ENERGY CONVERSION SYSTEMS

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Describe and explain the principles of various electrical energy conversion systems used in industrial and domestic applications.

CO2: Summaries the working of various mechanical and thermal systems and able to explain the performance evaluation of the system.

CO3: Calculate and choose the various Electrical equipments and able to know the factors affecting the performance of the electrical system.

CO4: Relate the significance of waste heat recovery systems and its consideration for improvement.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S					M	S			
CO2		S					S		M	
CO3		S					S			
CO4	M						S			

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION **9 Hours**

Classification of Energy Sources, Principle Fuels for Energy Conversion: Fossil Fuels, Nuclear Fuels.

Conventional & Renewable Energy, Energy Sources: Prospecting, Extraction and Resource Assessment and their Peculiar Characteristics.

Direct use of Primary Energy Sources, Conversion of Primary into Secondary Energy Sources such as Electricity, Hydrogen, Nuclear energy.

Energy Conversion through Fission and Fusion, Nuclear Power Generation.

MECHANICAL ENERGY **9 Hours**

Compressed Air System: Types of air compressors, compressors efficiency, efficient

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compressors operation, Compressed air system components, capacity assessment, and leakage test, factors affecting the performance.

Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies.

THERMAL SYSTEMS **9 Hours**

HVAC, Refrigeration and Air Conditioning: Vapor compressor refrigeration cycle, refrigerants, coefficient of performance, capacity, factors affecting refrigeration and air conditioning system performance, Vapor absorption refrigeration systems: Working principle, type and comparison with vapor compressor system.

ELECTRICAL SYSTEMS **9 Hours**

Transmission and Distribution losses, Pilferage, Transformer losses. Electricity tariff, Load management and maximum demand control, power factor improvement and its benefits, Selection and location of capacitors.

Electric Motors: Types, Losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, Energy efficient motors.

CO-GENERATION, TRI-GENERATION & WASTE ENERGY RECOVERY **9 Hours**

Co-generation & Tri-generation: Definition, need, application, advantages, classification, saving Potential.

Waste Heat Recovery: Concept of conversion efficiency, energy waste, waste heat recovery classification, advantages and applications, commercially viable waste heat recovery devices.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. A.W.Culp, “Priciples of Energy Conversion”, Mc Graw-Hill International, 1999.
2. Charles H Butler, “Cogeneration”, McGraw Hill Book Co., 1984.
3. Sengupta Subrata, Lee SS EDS, “Waste Heat Utilization and Management”, Hemisphere, Washington, 1983.
4. “Industrial Energy Conservation Manuals”, MIT Press, Mass, 2007.
5. R.D. Begamudre, ”Energy Conversion Systems”, New Age International Publisher, 2006.
6. Frank krieth, D yogi Goswami, “Handbook of energy efficiency and renewable energy”, Boca Raton: CRC Press, 2007.

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U14MC*E* 603

ENERGY MANAGEMENT AND AUDITING

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Classify the importance of energy management and costing requirement.

CO2: Describe and apply the basic measurement, instruments for measuring various parameters in energy systems in energy auditing.

CO3: Relate the significance of waste heat recovery systems and its consideration for improvement.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S	S		M		M	S		S	S
CO2						S	S			S
CO3							S			

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

ENERGY MANAGEMENT 9 Hours

Importance of Energy Management, Need of Energy Management, Scope of Energy Management, Energy Economics - Discount Rate, Payback Period, Internal Rate of Return, Life Cycle Costing

Direct use of Primary Energy Sources, Conversion of Primary into Secondary Energy Sources such as Electricity, Hydrogen, Nuclear energy.

Energy Conversion through Fission and Fusion, Nuclear Power Generation.

ENERGY AUDITING 9 Hours

Methodology with respect to Process Industries -Power Plants, Boilers. Characteristic Method Employed in Certain Energy Intensive Industries, Analysis of Past Trends (Plant Data), Closing the Energy Balance, Laws of Thermodynamics, Measurements, Portable and On Line

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Instruments.

THERMAL ENERGY **9 Hours**

Boiler – Efficiency Testing, Excess Air Control, Steam Distribution, Losses in Boiler, Methodology of Upgrading Boiler Performance ,Use - Steam Traps, Condensate Recovery, Flash Steam Utilization and Thermal Insulation.

ELECTRICAL ENERGY **9 Hours**

Energy Management Opportunities in Electrical Heating, Lighting System and Cable Selection. Demand Control, Power Factor Correction, Load Scheduling/Shifting, Motor –variable speed Drives-adjustable AC drives- Efficiency Testing- Speed Control. Energy Conservation in Pumps, Fans, Compressed Air Systems, Refrigeration & Air Conditioning Systems.

WASTE HEAT RECOVERY **9 Hours**

Recuperators, Regenerators, Heat Pipes, Heat Pumps, Cogeneration - Concept, Options (Steam/Gas Turbines/Diesel Engine based), Selection Criteria, Control Strategy. Heat Exchanger Networking - Concept of Pinch, Target Setting, Problem Table Approach, Composite Curves, Demand Side Management.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. CB Smith, "Energy Management Principles", Pergamon Press, New York, 1981.
2. Hamies, "Energy Auditing and Conservation; Methods, Measurements, Management & Case Study", Hemisphere, Washington, 1980.
3. Trivedi, PR, Jolka KR, "Energy Management", Commonwealth Publication, New Delhi, 1997.
4. Institute of Fuel, London, "Waste Heat Recovery", Chapman & Hall Publishers, London, 1963.
5. Sengupta Subrata, Lee SS EDS, "Waste Heat Utilization and Management", Hemisphere, Washington, 1983.
6. "Handbook on Energy Efficiency", TERI, New Delhi, 2001.
7. "Industrial Energy Conservation Manuals", MIT Press, Mass, 2007.

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ELECTIVE VII

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U13MC*E* 701 **INTELLECTUAL PROPERTY RIGHTS**

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Distinguish various property rights.
CO2: Describe the procedures to obtain Intellectual Property Rights.
CO3: Explain and choose on the effective usage of IPR's with some case studies

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S					S				S
CO2	S	M	M		M				S	
CO3	S					S			S	

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION **9 Hours**

Introduction - Invention and Creativity - Intellectual Property (IP) - Importance - Protection of IPR - Basic types of property (Movable Property, Immovable Property and Intellectual Property).

PATENTS, COPYRIGHTS AND TRADEMARKS **9 Hours**

IP - Patents - Copyrights and related rights - Trade Marks and rights arising from Trademark registration - Definitions - Industrial Designs and Integrated circuits - Protection of Geographical Indications at national and International levels - Application Procedures.

INTERNATIONAL CONVENTION RELATING TO INTELLECTUAL PROPERTY **9 Hours**

Introduction - Establishment of WIPO - Mission and Activities - History - General Agreement on Trade and Tariff (GATT).

IPR STRATEGIES **9 Hours**

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Indian Position Vs WTO and Strategies - Indian IPR legislations - commitments to WTO-Patent Ordinance and the Bill - Draft of a national Intellectual Property Policy - Present against unfair competition.

CASE STUDIES **9 Hours**

Case Studies on - Patents (Basumati rice, turmeric, Neem, etc.) - Copyright and related rights - Trade Marks - Industrial design and Integrated circuits - Geographic indications - Protection against unfair competition.

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Subbaram N.R., S. Viswanathan "Handbook of Indian Patent Law and Practice", Printers and Publishers Pvt. Ltd., 1998.
2. Eli Whitney, “United States Patent Number: 72X”, Cotton Gin, March 14, 1994.
3. Intellectual Property Today: Volume 8, No. 5, May 2001, [www.iptoday.com].
4. Derwent IP Matters “Using the Internet for non-patent prior art searches”, 2000.
5. [www.ipmatters.net/features/000707_gibbs.html.]

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U14MC*E* 702

COMPOSITE MATERIALS FOR SUSTAINABLE DEVELOPMENT

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Recognize the need and characteristics of the composite materials
CO2: Explain the manufacturing processes & quality inspection methods involved in the manufacturing of composite materials
CO3: Calculate the Engineering constants for an angle lamina .
CO4: Characterize the laminates by finding static mechanical characteristics .
CO5: Explain the applications of composites and its sustainability

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S		S						S	M
CO2	S	S			M					
CO3	S	S							S	
CO4	S		S			M				
CO5	S					M	S		S	

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

INTRODUCTION TO COMPOSITE MATERIALS 9 Hours

Need and general characteristics of composite materials- mechanical advantages and limitations Characteristics of fibers and matrixes – classification of composites – Prepregs – Lamina, Laminate and sandwich construction.

MANUFACTURING AND QUALITY INSPECTION 9 Hours

Fundamentals of curing – Bag molding process – compression and vacuum molding – filament winding – Quality inspection methods for raw materials – cure cycle monitoring – cured composite parts.

ANALYSIS OF LAMINA 10 Hours

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Fiber matrix interactions – Hook's law for different types of materials – relationship of compliance and stiffness matrix to engineering constants of a lamina – angle lamina: Engineering constants

ANALYSIS OF LAMINATES AND ITS PERFORMANCE **11 Hours**

Laminate code – stress – strain relations for a laminate – In-plane and flexural modulus of a laminate – lamination theory – Performance – static mechanical properties

APPLICATIONS OF COMPOSITES AND SUSTAINABILITY **6 Hours**

Applications of composites - Natural fibers needs and its significance - Recycling of composites

Topics of interest (Not for evaluation purpose)

Crack propagation in composites
De-lamination prediction in composites
NDT for composites
Joining of sandwich structures

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Mallick P K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, 1993.
2. A K Kaw, "Mechanics of composite materials", CRC press, 2014.
3. R M Jones, "Mechanics of composite materials", Taylor and Francis, 1999.
4. Halpin J C, "Primer on Composite Materials, Analyis", Techomic publishing Co., 1984.

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U14MC*E* 703 DIGITAL SIGNAL PROCESSING

L	T	P	C
3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Explain the characteristics of discrete-time signals and discrete systems
CO2: Analyze signal / system properties using mathematical tools
CO3: Apply and develop algorithms for digital systems
CO4: Illustrate efficient computation of DFT
CO5: Discuss advanced features and architecture of generic P-DSP

Pre-requisite

1. U14MCT 501- Signals and Systems

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	S									
CO2	S	S		M						
CO3		S			S					
CO4	S								S	
CO5	S		S							

Course Assessment methods:	
Direct	**Indirect**
Internal test I Internal test II Internal test III End semester Examination Assignment	Course end survey

DISCRETE TIME SIGNALS AND SYSTEMS **9 Hours**

Representation of a CT signal by samples – Sampling theorem – Reconstruction of a signal from its samples – Aliasing – DT Signals – Impulse, Step, Pulse, Sine, Exponential – Properties of DT signals - Transformation of independent variable – Shifting, scaling, folding - Discrete Time LTI systems – Properties – Impulse response – Convolution sum – Properties of Convolution.

Z-TRANSFORM AND SYSTEM ANALYSIS **9 Hours**

DTFT – Properties - Z transform – Forward Transform - Inverse Transform using Partial Fractions - Properties – Pole-Zero plot– Difference Equations - Transfer function - Analysis of Discrete Time systems using DTFT and Z Transform.

DISCRETE FOURIER TRANSFORM **9 Hours**

Introduction to DFT – Properties of DFT – Efficient computation of DFT – FFT algorithms – Introduction to Radix - n algorithms – Radix – 2 FFT – Decimation-in-Time and Decimation–in-

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Frequency algorithms – Butterfly diagram.

DESIGN OF DIGITAL FILTERS **9 Hours**

FIR filter design: Linear phase characteristics - Windowing Technique –Rectangular, Hamming, Hanning, Blackmann windows – IIR filter design: Analog filter design - Butterworth and Chebyshev approximations – Impulse invariance and Bilinear transformations - FIR and IIR filter structures – Direct form I and II - cascade and parallel forms – Finite Precision effects.

ADVANCED TOPICS AND PROGRAMMABLE DSP CHIPS **9 Hours**

Concepts of multi-rate signal processing – Decimation and interpolation by integer factor – Sampling rate conversion – Introduction to DSP architecture - Von Neumann, Harvard, Modified Harvard architectures – MAC unit–Multiple ALUs Modified Bus structures and memory access schemes in P-DSP – Multiple access memory – Multi-ported memory – VLIW architecture –Pipelining – Special addressing modes

Theory: 45Hr **Total Hours: 45**

REFERENCES

1. Mrinal Mandel and Amir Asif, "Continuous and Discrete Time Signals and Systems", Cambridge International Student Edition, Cambridge University Press, 2007.
2. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing, Principles, Algorithms and Applications", PHI, 3rd Edition, 2000.
3. B. Venkataramani, M. Bhaskar, "Digital Signal Processors, Architecture, Programming and Applications", Tata McGraw Hill, New Delhi, 2003.
4. Johny R. Johnson, "Introduction to Digital Signal Processing", PHI, 2009.
5. Won Y. Yang et. Al., "Signals and Systems with MATLAB", Springer International Edition, 2009.
6. Steven W. Smith, "The Scientists and Engineer's Guide to Digital Signal Processing", California Technical Publishing, 1997.
7. James H. McClellan, Ronald W. Schafer, Mark A. Yoder, "Signal Processing First", 2nd Edition.

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U14MCINX CERTIFICATION PROGRAM

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Program / design / analysis / control mechatronics systems using modern tools which are used in industry.

Pre-requisite

Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak										
COs	Programme Outcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1			S		S					S

Course Assessment methods:	
Direct	**Indirect**
Authorized Certificate from the agency	

The following certification courses are considered for one credit course. The main objective of this course is to make the students employable, industry ready and to help them to pursue higher education. This course is optional, self study and self funded course. The student can choose any one of these courses (U14MCIN01) from the following list to earn one credit from 3rd to 8th semester. The students can opt only one certification course as additional course in any one of the semester mentioned above. It is restricted to maximum of three courses during their study. The program should be minimum of 15 hours and the certificate should be provided after conducting the examination by the concerned agency.

S.No.	Course code	Name of the course	Certification agency
1.	U14 MCIN01	Labview Associate Developer	National Instruments
2.	U14 MCIN02	Robot Certification	Fanuc Robotics, ABB Robotics, KUKA Robotics
3.	U14 MCIN03	CAD software Certification	Autodesk, Catia, Soldworks, ProE
4.	U14 MCIN04	PLC certification	Siemens, Allen-Bradley, Fanuc

Signature of the chairman BOS /
Department of Mechatronics Engineering