BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY), PUNE

Faculty of Engineering & Technology
B. Tech. (Robotics & Automation)
New Syllabus

BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY) Pune.

Faculty of Engineering & Technology
Programme : B. Tech. (Robotics & Automation)
(2020 Course)

Course Structure & Syllabus
(Choise Based credit system-2020)
B. Tech. (Robotics & Automation)
Sem- I to VIII

Curriculum (2021-22) Manual1.

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Executive summary

Students pursuing engineering studies need to be well equipped and state of art with the latest technological trends and industrial requirements. To produce the students with high caliber and technically sound, enrichment in the curriculum content and various quality initiatives are needed. This is possible only when the students undergo studies with an updated and evolving curriculum to match global scenario.

Curriculum Development History

- In ambits of Deemed University- 2000
- Curriculum of SPPU Accepted
- First Revision in 2004
- Second Revision in 2007
- Third Revision in 2011
- Fourth Revision in 2014
- Fifth Revision in 2018 was expected

The proposed curriculum is developed to inculcate the advanced engineering skills to cope up with upcoming industrial and societal needs. Students will be imparted with advanced contents from respective field and innovative delivery methods.

To inculcate the advanced engineering skills and knowledge, branch specific courses have been introduced from the Sem – I itself. There are total 38 theory courses, 4 vocational courses, 3 MOOCs, 2 projects, technical research paper writing, no. of application software courses, no. of practical based courses, 6 Industry taught courses along with 60 days exclusive internship have been incorporated in the curriculum with 230 credits and 6500 Marks.

There will be collaboration with the prominent industries to execute the vocational courses. These industries will deliver the content and execute the hands-on session to inculcate the required engineering skills of particular course. Also, one course per semester will be entirely delivered by the expert/s from the industry of respective field for which blended teaching learning will be adopted.

Students will apply the knowledge of respective courses and develop the prototype/ model as a part of project based learning.

To give the experience of technical writing and research article, students have to develop the two projects in pre final and final year respectively and shall submit the research article to reputed journal for publication. This will inculcate research aptitude among students and will enhance the research profile of institute also. Incorporation of various practical based courses in respective discipline, will give hands on experience to students to understand the engineering concept in better way. Nowadays all practices and process in the field are being computerized and automated. Hence, it was pertinent to increase software content in the curriculum. It was demand from the industry that every engineer should be conversant with Software/Programming/Data analysis and automation process. Hence, courses to such as C, C++, Python, Machine Learning, Artificial Intelligence are added in curriculum of all discipline. Students who wish to develop their career in the IT field, significant courses related to computational engineering and application software have been incorporated in the curriculum of each discipline.

National Education Policy is insisting the Online and Digital Education and Ensuring Equitable Use of Technology. To inculcate the self-learning approach amongst the students, proposed curriculum has introduced Massive Open Online Courses to all the students to provide an affordable and flexible way to learn new skills, advance the career and deliver quality educational experiences at scale.

2. Curriculum Content

- Curriculum derived from Latin word 'Currere', which means a race course or runway on which one runs to reach a goal.
- Curriculum is the instructional and educative programme by following students achieve their goals, ideals and aspirational life.
- Curriculum is a standards based sequence of planned experiences,

  which students practice and achieve proficiency in content and applied learning skills.
- Its confidence building process.
- Its total learning experience of the individuals.
- Its interactive system of instructions and learning with specific goals, contents, strategies, measurements and resources.
- The desired outcome of curriculum is successful transfer / development of knowledge, skills, and attitude.
- Curriculum should lead to transformation of student to contributory member of the society.

  We tried to develop curriculum , which will meet these concepts.

Curriculum is the outline of concepts to be taught to students to help them meet the content standards. **Curriculum** is what is taught in a given course or subject. It refers to an interactive system of instruction and learning with specific goals, contents, strategies, measurement, and resources. It is a course of study that will enable the learner to acquire specific knowledge and skills. A **curriculum** consists of the "roadmap" or "guideline" of any given discipline. Both the philosophy of teaching of the instructors as well as of the educational institution serve as two of the principles upon which a curriculum is based.

In Engineering, a **curriculum** is the combination of instructional practices, learning experiences, and students' performance assessment that are designed to bring out and evaluate the target learning outcomes of a particular course. It is the goals, assessments, methods, and materials used to teach a particular skill or subject and includes thinking under "skill.". The curriculum needs to be planned

and designed in such a way so as to sequentially improve students' knowledge and skills.

Placement is an important parameter and outcome of a good curriculum, which satisfy the need of good placement. The written curriculum is a plan of what is to be taught so that the student gets good placement. For this , a variety of technical and non-technical courses that are required to complete a specific degree so as to help the student for placement are included in the curriculum. In addition to technical knowledge , it should also include social behaviors as well as content and thinking skills.

Overall, the curriculum should be such that it should develop a student in a good job seeker, good entrepreneur and also a good human being.

All the above aspects are taken care in the curriculum of **B. Tech-2021** course. This will develop different abilities in a student.

3. Curriculum Preamble

The curriculum 2021 is formed such that it will develop different abilities in a student. It a combination of blended teaching learning process in which both online and offline teaching is a part of the curriculum. In order to develop affection towards the discipline a student has selected, core discipline courses are included right from first year. This will also help to give the overall idea about the branch / discipline to the student.

Interaction with the industry is increased in this curriculum by introducing two new concepts –

1. **Vocational Course** and 2. Industry Taught Course.

Vocational Course (VC), a student will able to develop a specific skill set from the relevant people/ agency from the industry. This will add in gaining new skill sets required by the industry. Such Vocational Courses are included from Semester III to Semester VI of the curriculum. Department also design vocational course relevant for the discipline, which add practical knowledge to students. The vocational courses should be discipline specific. 4 vocational courses and 8 credits are integrated with curriculum.

Industry Taught Courses (ITC) are the courses which will be taught by the people from industry who are experts in the relevant field, either partially or fully. This will provide a scope to students to gain the latest knowledge as used in industry and also to have direct one on one interaction with the industry. This will develop a confidence among the students. Such teaching by industry experts will be as per their availability, if required online and other than official college hours also. Thus, there is a blend of online and offline teaching, knowledge from academicians as well as from industry. Total six Industry Taught Courses are included in the curriculum.

Industry Internship of 60 days at the end of Semester VI integrated with curriculum, will also add to the interaction with the industry. A student will avail his training in industry or on site or in any design office or research organization as allotted to him/by the institute. A separate logbook will be maintained by the student during this period duly signed daily by the competent authority.

Project Based Learning is a part of almost each course of the curriculum. Small projects on relevant topics will be allotted to the students as a part of term-work

of that course. This will inculcate the habit of applying the knowledge learnt to solve practical problems.

Two Projects are included in two stages, one in third year (Sem V and Sem VI) and the second in final year (Sem VII and Sem VIII). Improvement in Research, thinking ability and application of theoretical knowledge to develop practical ideas is the main purpose of these projects.

Publication of a research paper is the outcome expected from the Project work and as a motivation, separate credits are allotted for this. Students are expected to write research article based on Project-I in standard journals in final year. Guide for Project -I will help in writing the research article.

To develop the self studying, self-learning skills, each student has to join the **MOOC/NPTEL** courses and will get the certification of the respective course. This will also give him/her a chance to get the knowledge from teachers from well known institutes of national repute. Three such MOOC/NPTEL courses are included each in Semester III, Semester V and Semester VII and separate credits are allotted to it.

Various new courses are introduced in the curriculum thereby introducing the current and latest technology to students. Basic Science and Engineering Science course contents are designed to match the requirement of the specific disciplines.

Number of software related to that branch/ discipline are included as part of the curriculum. This will help the students to get good placement.

Few soft courses are introduced to non-circuit branches. This will give a soft feel to such branches and also to inculcate confidence among the students.

In addition to technical abilities, a student needs to be developed as a good human being. For this, he will complete social activities in Semester IV and Sem VIII.

Thus Curriculum-2021 satisfies the requirements of National Education Policy-2021.

"Knowledge, Skill, Behavior" are the three attributes that are inculcated in a student when he completes his B.Tech. course under Curriculum-2021.

Recommendations considered

- UGC- Quality mandate
- National Education Policy (NEP)

- AICTE model curriculum
- Curriculum of International Universities
- Curriculum of Indian Universities
- Feedback from HR of industries called for placements
- Market perception

Methodologies Adopted In Designing Curriculum (2021-22)

- 19 Basic Points for design of Curriculum
- Listing of common points (credits, marks, No. of courses, common courses, industry taught courses, vocational Programmes etc.)
- Conducted series of meetings
- Conducted in depth one on one discussions with HoDs
- Planned three workshops,
- Eminent experts from Industry, IITs, IISER, NIT, SPPU, Central Universities were invited for workshops
- First workshop - Course structure, Titles of courses, Industry taught courses, Vocational Courses.
- Second workshop - Content of first and second year courses
- Third workshop - Content of third and fourth year courses- (Planned)

4. Salient features

- Total 250 contact hours teaching are incorporated.
- Credit based 38 theory courses being offered to achieve global standards of quality.
- Curriculum offers practicals to more than 80 % (~ 30 theory courses) theory courses.
- Total 230 credits (6500 marks) are offered for the entire B. Tech. programme.
- Theory courses contains 60% of courses and 20% to practical courses.
- Tutorials (6 Credits), online courses (6 Credits), vocational courses (6 Credits), projects (18 Credits), internship (3 Credits), Research Publication (2 Credits) and social activities assigned (4 Credits) contains remaining 20% of credits
- Blended education policy is adopted considering its importance. 20% courses are taught in online mode.
- Incorporation of 6 industry taught courses is one of the important and strategic step.
- Adopting 4 vocational Programmes in cooperation with industries, renowned agencies, universities will improve skillsets of our students.
- 60 days industrial internship to meet the requirements of industry.
- Including of 2 projects to enhance technical skills & self learning.
- Research paper based on Project-I will inculcate research aptitude among students.
- Project based learning practically for all courses will enhance the ability of application of knowledge and problem solving aptitude.
- NPTEL/ MOOC courses in online mode are introduced as integrated part of the course structure.
- To understand social responsibility and social activities of weightage of 4 credits are integrated part of the course structure.
- Quantitative Techniques and communication courses are introduced to enhance the analytical ability of students and address employability.
- Wide range of elective courses have been offered to provide the choice, to explore the knowledge in their domain of interest.

Salient Features

Sr. No.	UGC (Quality mandate)/ NEP2020-Recommendations	Curriculum (2021-22)
1	Learning Outcome-based Curriculum Framework (LOCF)	a) Programme outcomes and course outcomes are being made ready
2	Imparting Life Skills to Students.	a) Quantitative techniques b) Communication skills c) Bridging gap with Industry by vocational courses d) Self learning by NPTEL/PBL/Two projects
3	Social and Industry Connect	a) 6 Industry taught courses b) 4 Vocational courses c) 60 days internship d) Time and credits for social activities
4	Promotion of Research and the Creation of New Knowledge.	a) Research publications based on projects b) Project based learning
5	Blended Education	a) 15% courses in online mode b) NPTEL/MOOC courses in online mode
6	Technology Enabled Learning/Self Learning	a) NPTEL/MOOCS
7	Software Applications	a) Programme specific softwares and Software application Courses

5. Curriculum Details

5.1. Courses-Theory/Practical's/Tutorials/Units/Co-mapping and Engagement

Courses-Theory/Practical's/Tutorials/Units/Co-mapping and Engagement, University exam and internal assessment

The B.Tech. 2021 offers Credit and Outcome based curriculum with total 230 credits, required for graduation with a Bachelors' degree (B.Tech). The Under-Graduate Programme (B.Tech) is of four years duration i.e of eight semesters (two semesters/year).

Engagement of Courses:

The courses in revised curriculum structure of B.Tech. program are categorized under Core courses, Elective courses, Engineering Science courses and Basic Science courses. These courses are taught to students by engaging them through lectures, practical or tutorials by respective course coordinators. From semester I to VI, there are five (lecture engaged and assessed) courses and in semester VII and VIII there are four (lecture engaged and assessed) courses which are mandatory. All the courses have varying hours of engagement and credits. Theory lecture engagement varies between 3 hours to 4 hours/week, practical engagement varies between 2 hours to 4 hours/week for the respective courses. The contents of every course is divided into six units. Each unit can be covered in 6 hours or 8 hours depending on the total allotted hours/week of lecture engagement for the respective course. Some courses are solely practical oriented. These courses will be only engaged through laboratory sessions.

Outcome Based Curriculum:

Planning and realization of teaching and learning related to outcome-based curricular model requires that initial element shall be an outcome. It serves as a basis for defining modes of evaluation and validation of outcomes. The curriculum defines the Course Outcomes (COs) and course objectives for every course. The outcomes are assessed through various activities and evaluation of learner's performance in various examination schemes i.e Theory/Practical/Oral/Term work.

Credit Calculation:

The course credits are computed based on the teaching hours per week for that course using the formula as mentioned below.

Credits earned by the Student = Credits earned in Theory (Th) + Credits earned in Practical (P) / Oral (O) + Credits earned in Tutorial (T)

Here, as mentioned above, the credit assignment for Th/P/O/T of any course is based on number of teaching hours of that course. It is as mentioned here:

Number of Credits for Theory (Th) courses = Number of classroom teaching hours per week for that course (1:1 correspondence)

Number of Credits for Practical (P) / Oral (O) courses = Number of laboratory hours per week for that course / 2 (0.5:1 correspondence)

Number of Credits for Tutorial (T) courses = Number of tutorial hours for that course (1:1 correspondence)

Example: If a course has 4 hours of classroom teaching, 2 hours of laboratory session and 1 hour of tutorial, then the credits assigned for that course will be 4(Th), 1(P/O) and 1(T) respectively.

Examination Pattern:

A) University Examination (UE)

The pattern for theory examination is of 60:40, where the learner can earn 60 Marks (maximum) through University Examination (UE) and 40 marks (maximum) are assigned for Internal Assessment (IA). For the UE of Practical/Oral assessment, the total marks allotted are 50. The laboratory assessment is divided into three assessment heads viz. Term work (TW), Practical (P) and Oral (O). The students will be assessed through TW or P or O or combination of any of these for the courses that have practical assessment. 25 Marks are assigned to TW/P/O each, so when a learner is assessed for practical through TW and P heads, he/she will be assessed for 50 marks.

B) Internal Assessment (IA)

The Internal Assessment (IA) for the respective courses will be performed through Unit Tests (UT) and Assignments. Total two UTs of 20 marks each will be

conducted and the average marks of these two UTs will be considered. Similarly, course coordinators will design the class assignments in terms of exercises, case studies, real world problems or mini projects, which the learners have to submit from time-to-time, as mentioned by the deadline of each assignment. While designing the assignment, the course coordinators will provide the assessment criteria to the learners and maximum score (marks) for the assignment as well. If there are multiple assignments, then the average of score (from score attained in all assignments) will be calculated and considered as IA marks. This way, the learner will be assessed for 20 marks (maximum) for assignments.

Hence, total marks for UT and assignments are 20 each and so, IA will be of 40 marks. The score for IA is calculated as:

IA Score attained by learner (Max 40) = Average Score attained in UTs (Max 20) + Score attained in Assignments (Max 20)

5.2. Credit Concept: Equivalence

In CBCS 2021 Course structure, the allotment of credits are as follows:

Theory class of 1 hour: 1 Credit

Practical class of 2 hours: 1 Credit

Tutorial class of 1 hour: 1 Credit

Project, Research Paper & Social Activity: 1 Credit

5.3. Vocational course

Vocational learning opportunities play a important role in skill development and employability of student. Vocational courses are ways of implementation of theoretical knowledge in the practice. The importance of vocational development can largely be summed up as the difference between theoretical knowledge vs. practical skills. The vocational courses are based on the teaching of practical skills. These courses are designed to introduce the manual skills in the professional education in addition to the theory. These courses will serve as bridge courses for professional growth and career improvement.

Aims & objectives of vocational courses:

- To provide students with technical knowledge and skills necessary for progressive education in engineering profession.
- To give a better understanding of the emerging of technology.
- To train the student with necessary skills leading to skilled personnel who will be enterprising and self-reliant.
- To enhance the skill of students for becoming self-sustained engineer.
- To reduce the mismatch between the demand and supply of skill man-power.

In this curriculum at B.Tech Programme, there are four vocational courses introduced i.e. in Semester III, IV, V and VI. The courses offered at these semesters are as per the requirement of the programme.

Methodology:

The vocational courses shall be conducted in association with the companies through MoUs. The candidate shall be provided training in the industries in respective area. The training can also be given by the company experts in the college with appropriate infrastructure. Departments can design vocational programme/course as per employability skills for an engineer of respective discipline required. The student shall have to attend the training sessions for at least 4 hours per week. The training sessions shall be organized on weekends or on the extended hours of the college timing.

A faculty-in-charge will be appointed to monitor the functioning of the vocational

course as well as monitor the performance of the student for the said course.

The student has to maintain proper record of the training attended throughout the semester and submit the report on the work carried out. The record has to be checked and signed by the faculty –in-charge.

Assessment:

The assessment of the performance of the candidate for the vocational courses shall be in the form of term work and oral. The term work and oral carry 50 marks. The candidate performance shall be evaluated based on the training undertaken by the candidate throughout the semester. Student shall give presentation of skills he learned through vocational courses followed by viva. External examiner for the same shall necessarily from relevant industry.

A total of 2 credits shall be allotted per vocational course per semester.

Certificate:

Every candidate shall be awarded a certificate after successful completion of the vocational course as per the rules & regulations.

The certificate shall be jointly signed by concerned authorities of college and the company.

5.4. Industry Taught Courses

PREAMBLE:

The concept of Industry Offered Courses enables bridging of technological gaps between students and state-of-the-art technologies used current in the industry.

OBJECTIVES: To

i. Impart the state-of-art technology course existing in the industry.

ii. Expose students to application of technologies adopted by industry.

iii. Train students for solving real-world projects in respective industries by applying technical knowledge gleaned from an industry expert

iv. Make students draw benefit from the experience of veterans from industry. Knowledge sharing by industry experts.

v. Align student's mind-set towards industrial environment through the instructor from industry. Provide industry instructor lead courses.

CREDIT/HRS.:

Percentage of Industry Taught Courses in the programme =……%

METHODOLOGY:

A) A faculty shall be appointed as course co-ordinator. Roles and responsibilities of Course coordinator are as follows:

(i) Act as a liaison between identified Industry expert and department.

(ii) Arrange schedule of lectures in consultation with identified Industry expert.

(iii) Keep record of students' attendance.

(iv) Collect feedback from students and suggest changes and modifications in lecture delivery method by industry subject expert.

(v) Keep record of Unit Test Performance and Practicals along with experts.

(vi) Organise visit to the industry relevant to the course.

B) Execution:

(i) The Identified industry expert can conduct theory classes on weekends or as per convenience of Industry experts either through offline or online mode. The courses which are to be taught by expert from industry are already identified and confirmed in workshop-I

(ii) Practical sessions will be conducted by course coordinator. Panel of experts from Industry shall be identified to teach the course before the commencement of the respective semester and submitted for the approval of the Head of the Institution with financial layout.

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COLLEGE OF ENGINEERING, PUNE – 411043.

Approval format for Expenditure for Industry Taught Course

Date:

Name of the Department: _____

1. Budgetary allocation for industry expert (As per Budget 2021-22) Please mention total amount (in Rupees) and other bifurcations, if made---------- (to be filled at college level)
2. No. of Lectures (Industry offered Course wise / Subject wise) required with specific subjects:

Sr.No.	Title of the course	Name of Department	Semester	Work Load per week	Details of Industry Expert(s)				Total Remuneration
					Name & Designation of Expert	Name of the company	Contact Details	Honorarium per lecture	
1									
2									
3									

Recommendation for Course Coordinator
Recommendation for HoD
Recommendation for Principal

3. Total financial Outlay for honorarium of Faculty: (Industry taught courses-Subject wise): with number of lectures (in Hours) in UG sections

Sr. No.	Name of industry Expert	Honorarium	Financial Outlay (in rupees)
1			
Total			

Signature of HoD **Signature of Principal**

Request format-To Industry Expert

To

……

Subject: Industry Taught Course (ITC) for B.Tech (…..) , Sem-_____

Dear Sir,

Greetings from Dept. of _____, Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune

Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune, BV(DU)COEP an AICTE approved institution, was established in the year 1983 and is a constituent unit of Bharati Vidyapeeth (Deemed to be University), accredited (3rd Cycle) with 'A+' grade by NAAC and NBA.

In the national arena, BV(DU)COE Pune has been among top 100 Engineering Colleges of India, consecutively for five years (99th ranking in 2020) by MHRD in June 2020. It has also been ranked 20th at national level by AICTE Internshala for internships. Our reputation as India's premier engineering institution is further enhanced by being honored with the Platinum category by AICTE-CII survey. College is proud to be ranked 11th across India by the prestigious magazine India Today. DATAQUEST a leading journal, ranked BV(DU)COEP in 3rd position amongst the Top 50 Private T - Institutes of India. The college ranked 17th position in the survey conducted by Times of India in 2019.

----Brief about dept-----

The course curriculum has a multi-dimensional approach, it not only implements a dynamic, qualitative, and evolved structure and syllabus, but also incorporates a good and healthy mix of theoretical and practical exposure. In this regards the institute promotes and encourages courses in line with industry expectations and forthcoming challenges which should ease the students for undergoing industry offered courses for practical exposure of applications of Education system. This is much required to bridge the gap between Industry and Academia and by promoting industry orientation for creating a complete industry ready professional.

To fulfil these objectives, curriculum design, which will be implemented from the academic year 2021-22, B.Tech. program includes 6 courses taught by industry experts. With reference to the subject mentioned above, we request you to teach… ….. Total…… number of lectures (60 min each) are required to be delivered. A blended learning, to be offered for the students through combining online or offline teaching wherever and whichever is best possible. Therefore, I request you to send acceptance letter, mode of teaching, convenient day and time slot to teach the said course. Enclosed please find herewith standard format for reply.

With Thanks and Regards,

Sign and stamp of Head, Dept of _____

Enclose:- Course content

Reply

To

The Principal

BV(DU)

COE,

Pune.

Subject: - Acceptance for delivering/ conducting lecture of the course--------- of B.Tech(-----), Sem(----).

Ref.: - Your letter---------- dated-

Dear Sir,

This has a reference of your letter mentioned above. It gives me immense pleasure to accept your invitation to deliver lectures in the said course. Following will be the time-table for the lecture.

Sr. No.	Title of Course	Time	Days						
			Mon	Tue	Wed	Thu	Fri	Sat	Sun

Sincerely

<Signature >

< Name of Expert>

BHARATI VIDYAPEETH
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COLLEGE OF ENGINEERING, PUNE – 411043.

Date:

AGREEMENT TIME-TABLE

Name of department:

Name of industry taught course:

Sr. No.	Day	Date	Time Slot

(Name & sign. of HOD with date & stamp)

(Name & Sign. of Concerned Person)

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Industry Taught Courses (Assessment- Theory/ Practical)

- One course coordinator should be appointed for the course. All documents related to assessment of the course will be maintained by the course coordinator.
- Total assessment of Industry Taught Course -Theory is of 100 Marks.
- Assessment of this course consists of Internal Assessment and End Semester Exam which carry 40 Marks and 60 Marks, respectively.
- Internal Assessment consists of assignments and mini projects.
- One real world project (mini project) is considered as part of Internal Assessment.
- Students should give presentation on given topic.
- Industry expert should set question papers.
- In case of practical exam, industry expert can take oral exam (may be online) and students will perform the experiments in the presence of course coordinator in the department.

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B.Tech (Brach Name) Sem __

Title of ITC: - _____

Record of Lecture Taken

Sr. No.	Lecture No.	Unit no.	Date of Conduction	Topic Covered	No. of Students Attended	Sign

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Bill format for remuneration for Industry Taught Courses

(The bill should be submitted directly to the concerned department on or before 5th of every month)

1. Name of industry expert: _____
   Company/Industry name:
2. Name of the Department: _____
3. Remuneration for the Month: _____
4.

Name of the Bank	Branch	A/C No.	IFSC

5. Contact Details: -

Email	Cell Phone No.

6. Details of lectures delivered:

Sr. No.	Title of the Course	Class	Date	No. of lectures	Total Remuneration (Rs./lecture)
	Total				

Date: _____

_____

Signature of the Industry expert

Certified that has been appointed by the ----- dept as an industry expert for the course vide order No. _____

dated. _____has delivered _____lectures/taken classes during the month/ Sem _____

and is entitled to honorarium of Rs. _____(@Rs ------- /- per lecture/per day)

Course Coordinator: _____

_____

Signature of the Head of the Department with Seal

Date:

Receipt: -

Received with thanks ₹-------- from BVDUCOE, Pune towards conduct of -------- lectures of the course ---------- of B.Tech(-------), Sem--- --.

Signature of Industry Expert

BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY)
COLLEGE OF ENGINEERING, PUNE – 411043.

Payment Record
(Copy to be maintained in the Department)

Sr. No	Name of Department	Name of course	Name of Industry Expert	Name of company	Email	Mo. No	Address	Amount	Remark/ check number transaction id

Encl:
1) College voucher copy
2) NEFT/RTGS copy

5.5 MOOCs Implementation

To inculcate the self-learning approach amongst the students, proposed curriculum has introduced Massive Open Online Courses to all the students. It will provide an affordable and flexible way to learn new skills, advance the career and deliver quality educational experiences at scale.

Also, National Education Policy is insisting the Online and Digital Education and Ensuring Equitable Use of Technology.

A massive open online course (MOOC) is an online course aimed at large-scale interactive participation and open access via the web. In addition to traditional course materials such as videos, readings, and problem sets, MOOCs provide interactive user forums that help build a community for the students, professors, and teaching assistants (TAs).

BV(DU)COE Pune is having active NPTEL local chapter-partnership. Proposed curriculum has introduced three MOOCs at B.Tech Sem – III, Sem V and Sem VII with following objectives.

1. To provide e-learning through online web and video courses in Engineering by experts in the country in that subject.
2. To develop self-learning attitude in students.
3. To provide platform for knowledge enhancement of student's as per their area of interest.
4. To update students with advanced technologies.
5. To make the students more employable.
6. To prepare the students for competitive exams like GATE and also for higher studies.

Methodology of Assessment:

- Department shall publish list of NPTEL courses in every semester. Student can refer selected one of them in respective semester.
- Considering pre-requisite, proposed curriculum has provided with the various subject baskets as per the courses available.
- Students need to enroll for the course in each academic year as mentioned in the structure.

- Students need to attend all online lectures and complete all assignments as per schedule for registered course.
- Student will register and appear for exam conducted by NPTEL and shall submit the copy of course completion certificate received after passing the exam for registered course.
- Accordingly, the credits will be allotted to the student for respective MOOCs.
- Students have the flexibility to attempt the said course during the entire B.Tech Programme to earn the credits of respective MOOCs.
- NPTEL courses relevant to respective branch are only expected to select by students. Credits will not be awarded if general/ non engineering courses opted.

5.6 Project I and II

Project Stage I Objectives:

Provide help to the students

- In generating a new idea or modify existing system for solving societal, industrial and/or institutional problem.
- In review of literature that aligns with new idea and/or existing systems and clearly defining the problem
- In developing a workflow process/methodology for the desired system.
- In designing various components of the system assembly
- In developing a CAD model of the desired system.
- In writing the technical report based on the work completed

Project Stage II Objectives:

Provide help to the students

- In fabrication of the experimental setup/new system and/or purchase of standard components
- In pilot run and/or validation of new system for its performance
- In modifying the system if required to improve its performance.
- In detailed parametric studies of the modified system and analyzing the results
- In writing the technical report, research article and/or filing a patent.

Particular	Hours per week	Credits allotted
Project I stage I	2	4
Project I stage II	2	4
Project II stage I	4	4
Project II stage II	4	6

Assessment & Evaluation:

For Project-I Stage I & II		
Assessment Tools	**Assessed through**	**Marks**
	Presentation 1	10
	Presentation 2	10
	Presentation 3	10
	Continuous Assessment by guide	10
	Final Project demonstration, presentation & viva voce (University Examination)	60
	Total Marks	**100**

For Project-II Stage I & II		
Assessment Tools	**Assessed through**	**Marks**
	Presentation 1	20
	Presentation 2	20
	Presentation 3	20
	Continuous Assessment by guide	20
	Final Project demonstration, presentation & viva voce (University Examination)	120
	Total marks	**200**

Minimum number of in-sem. project presentations: 03

Parameters for evaluation of project in University examination

1. Idea of Project/Topic
2. Technical content
3. Innovation
4. Experimentation/Model development/Software development/Simulation development etc.
5. Participation as an Individual
6. Research Potential
7. Project Hardware/Software
8. Fabrication/Model/Equipment development
9. Data Analysis
10. Attendance
11. Timely completion
12. Report writing
13. Presentation

Prepare a format for report card of indicating progress, assessment and progressive evaluation of the project. This progressive evaluation record (PER) is prerequisite for university examination.

Progressive Evaluation Record (PER) shall be submitted in the department at the end of the semester and made available at time of university examination.

Format for Internal Examination for Project- I & II

B.Tech (------), Sem--------

Roll No.	PRN	Name of student	Term Work Marks			
			Presentation-I (10%)	Presentation-II (10%)	Presentation-II (10%)	Continuous Assessment by Guide (10%)

Format for University Examination for Project- I & II

Roll No.	PRN	Name of student	Parameter for assessment of project and marks for examination													Total out of 100	Any five parameters out of remaining
			Idea of Project/ Topic	Technical content	Innovation	Experimentation/Model development/ Software development/ Simulation development etc	Participation as an Individual	Research Potential	Project Hardware/ Software	Fabrication/Model/Equipment development	Data Analysis	Attendance	Timely completion	Report writing	Presentation		
			10	10	10	10	10	10	10	10	10	10	10	10	10		

Out of 13 parameters, parameters no. 1,3,4,6 & 8 are mandatory and may be considered for assessment of the project. Each parameter will carry 10 marks for Project-I & 20 marks for Project-II.

5.7 Social Activities for the Learners

A) Introduction

The prime objective of Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune is holistic development of students. The learner achieves the status as "whole" when he/she has not only achieved success in academics but also has succeeded in bringing the nation up by connecting with socially left-out elements and bringing ray of hopes into their lives. In this respect, the new curriculum encourages the learner on the social activities. In this case, student's social activities are provided by the colleges, but not limited to them. Total of four credits assigned for these activities.

B) Objectives

a) To make people create balances, so they do not only focus on academic aspects, but there can also be other aspects to have in life.

b) To build better relationship with others.

c) To create great balance with the academic aspects.

d) To learn and understand society.

e) To develop the nature of help and enhance the ethical norms for behaviors.

f) Teamwork

C) Outcome of Social Activities:

The social activities make a good impact on learners. The learner:

a) Will be able to understand the needs of society.

It enables a learner to consider the perspective of other people and understand their needs by interacting with people from diverse backgrounds.

b) Will be able to understand different perspectives and engage other cultures.

Social events develop social skills and empathy—the outward-oriented dimensions of emotional intelligence (EQ). The interactions or conversations elicited by events helps students build relationships, understand different perspectives and engage other cultures. Social events provide an opportunity to expand one's social circle.

c) Will be able to maintain positive outlook towards life.

With high adaptability to diverse situations and a good level of understanding of other's opinions, socially aware learners are less likely to indulge in negative behavior. They are also less vulnerable to stressful situations and have fewer chances of getting involved in undisciplined behavior. These students also have a more positive outlook on life.

d) Will be able to maintain good emotional health.

Social activities keep the learners sharp and mentally engaged, and this is important to prevent the onset of serious diseases like dementia or Alzheimer. Connecting with others helps keep you in a positive mood, which in turn wards off depression by improving physical health and maintaining good emotional health as well.

D) Sample list of Social Activities (not limited to them)

a) Organizing Educational Camps

Educational camps may be organized for the socially and economically week elements, especially in rural areas or even in the slum areas of the city, by making them aware of the importance of education and their own human rights.

b) Tree Plantation Drive

There are so many health benefits to having plants around – like fresher air, improved emotional state, and reduction of illness in and around the society. Tree plantation in this respect plays a crucial role. Just planting the tree is not enough but it should be made to grow to its extent.

c) Offer Helping Hand for Martyrs Family by Fundraisers

Soldiers fight for our country, securing our borders. They don't think of their family and sacrifice their lives for us, and what we do for them? Packages are announced every time after the death of our worriers but rarely reaches them. Families keep waiting for years. In this regard, few of these forgotten families can be visited and a small helping hand can be lend to them, to make them lead their further life peacefully. Fundraising in this respect, is a great student society social idea. It is incredible to see how people can bring positive change if they work together. The youth can make a team with an

external organization to take part in a purposeful community event as mentioned above.

d) National Service Scheme

It will help in the overall personality development of a learner by participating in projects that benefit the community. This extra-curricular activity is sponsored by the Ministry of Youth Affairs and Sports.

e) Felicitations of People who have contributed to the society but now forgotten by the society

There are so many intellectuals in our society who have achieved great heights in their field, who are stalwarts in different field but never came into limelight, their contribution is not recognized. Few of these can be invited publicly or visited at individual level by making a team and felicitate to appreciate their contribution towards the society or nation. Some of these stalwarts may be like Anand Kumar who teaches underprivileged students for IIT-JEE without a penny, Shekhar Naik who is the Captain of Indian Blind Cricket Team, Ranjeet Singh Desale who even being a rural teacher, is awarded by UNESCO with Global Teacher Prize, Ritu Biyani who fought cancer, traveled across the country to spread awareness.

f) Street Play on Social Awareness

This is also typically known as "Nukkad Natak". This form has been used to propagate social and political messages and to create awareness amongst the people regarding social issues. What is important is that the plays make the people think. The play is seen by many people of different age groups who then question and discuss the contents of the play. There have been several plays exposing the mechanism of black marketing and hoarding. Some talk of the use of political power for pressurizing people. Others highlight caste conflicts or ideas about hygiene and health. Street plays are also used to encourage literacy amongst villagers. Street plays on some of the topics like degradation of Indian media, hypocrisy, responsibility towards environmental concerns, brain drain, dilapidated educational structure, safety issues and rights for women. child labor, organ/human trafficking etc., can be thought of. The learners can participate in street play festivals like Manthan Mahotsav, the largest street play festival in India.

g) Poster Exhibition on Contributions of Heroes of India

The learners can organize an exhibition to not only display but explain the contribution of Indian Heroes who have been forgotten and remained in the book of history. Some of these inspiring heroes may be Mihir Sen, Khashaba Dadasaheb Jadhav, Anandibai Joshi – First woman doctor from India, Bhikaji Cama, Khudiram Bose, Baba and Prakash Amte etc. Such exhibitions make inspired, the youth of today's generation.

h) Waste Clean Drive

i) Educating literacy-poor societies about disposal of nature-harming objects

j) Distributing needful items for living in economically backward societies

k) Organizing early completion on national issues.

l) Cleaning of Public Places/ Traffic Management/ Police Mitra.

m) Organizing activities under engagement of people with Science and Technology.

Report of social activities conducted each student shall be prepared in standard format. Appropriate documentary evidences shall be part of report of students correspondence with respective authorities for social activities, permissions, certificates from Institutes/Organization/Local Government are essential documents for award of credits under this head.

E) Summary

Thus the interactions or conversations elicited by such social events help students to build relationships, understand different perspectives and engage other cultures and these events not only will uplift the moral of the society but also ignite minds of generations ahead to provide their support and enthusiastically participate in such activities. Such interactions will certainly provide an opportunity to expand their own social circle.

5.8 Internship

Internship of 60 days is incorporated as an integrated part of curriculum structure-2021. The primary objective of internship is to make students familiar with industry environment and to take up on- site assignment as trainees or interns in order to bridge the gap between theory and industrial practices. It is mandatory for students to undergo in-plant training after completion of semester VI in reputed industrial organization. The student shall submit the "Intern Certificate" issued by the industry organization as well as a technical report not exceeding 30 pages within the stipulated time to be eligible for making a presentation before the committee constituted by the department. On the basis of daily work carried out in the industry, student shall prepare a record book. This record book shall be checked and signed by his/her supervisor from the industry where he/she is doing internship on daily basis.

University examination carries 50 marks and after successful completion, student may be awarded 3 credits for the internship work. Standard format for record book shall be as below. Marks will be awarded out of maximum 50 and three credits will be given upon completion of internship towards the degree requirements, as per the regulations. Internship will ultimately assist students to apply theory learned in classroom to industrial practices so as to understand engineering/technical solutions in a global, economic, environmental and societal context.

5.9 Research paper publication

Research paper publication is one of the innovative features of programme curriculum- 2021.

1. It has been & introduced in 7th semester. Two credits are awarded for the same subject to publish of research paper. Student shall publish a research paper in peer reviewed/ Standard journal(not in paid journals) based on research work carried out for Project-I. Guide for Project-I shall be responsible for Writing manuscript, Selection of journal for publication, Submission of manuscript to the journal. Progress report of publication of research paper shall be prepared in standard format and submitted for the award of credits. Students shall be first author of research papers. No name either of faculty members except guide or other students shall be added without any contribution in research/project work. Format for progress report of research paper published (To be maintained by Guide). A departmental committee comprising of head of department, project guide, and one senior professor will review the progress of this activity periodically (not exceeding three months). The suggestions/comments offered by committee will be incorporated in due course of time to accomplish the task within a predetermined period.

2. Research paper publication as a integrated part of the course structure, will inculcate research aptitude among students. This will help there in seeking admissions in reputed International Universities for higher studies. Further, this research aptitude developed may enhance his employability also.

3. This activity is expected to generate 15 to 20 publication per year, which will enhance research profile of department and institute too.

4. Hence, there should be team of maximum 3 to 4 students per project except very exceptional projects. Prior permission to increase team size is essential.

Weekly progress report of the research paper publication.

Title of the project -

Name of the Guide -

Weekly schedule of meeting- Day------- Time-----

Student Details - Name--------- PRN------ Roll No.---

Sr. No.	Week No.	Date	Work completed/done by students per week

Bharati Vidyapeeth
(Deemed to be University)
College of Engineering, Pune
Department of Robotics & Automation Engineering

PROGRAM OUTCOMES

Engineering Graduates will be able to:

1. ***Engineering knowledge****: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.*
2. ***Problem analysis****: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.*
3. ***Design/development of solutions****: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriateconsideration for the public health and safety, and the cultural, societal, and environmental considerations.*
4. ***Conduct investigations of complex problems****: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis ofthe information to provide valid conclusions.*
5. ***Modern tool usage****: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activitieswith an understanding of the limitations.*
6. ***The engineer and society****: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevantto the professional engineering practice.*
7. ***Environment and sustainability****: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and needfor sustainable development.*
8. ***Ethics****: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.*
9. ***Individual and team work****: Function effectively as an individual, and as a member or leaderin diverse teams, and in multidisciplinary settings.*
10. ***Communication****: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and writeeffective reports and design documentation, make effective presentations, and give and receiveclear instructions.*
11. ***Project management and finance****: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member andleader in a team, to manage projects and in multidisciplinary environments.*

12. ***Life-long learning****: Recognize the need for, and have the preparation and ability to engage inindependent and life-long learning in the broadest context of technological change.*

Statements of Programme Specific Outcomes (PSOs)

PSO1:Apply the knowledge of design engineering, digital manufacturing, IoT, electronics engineering andcomputational sciences to solve Robotics & Automation Engineering problems.

PSO2:Apply Robotics & Automation Engineering principles for research, innovation and developentrepreneurial skills.

PSO3:Apply concepts of Robotics & Automation engineering to asses' societal, environmental, healthand safety issues with professional ethics.

Program Educational Objectives (PEOs):

Graduates will be able,

- *To fulfill need of industry and society with theoretical and practical knowledge.*
- *To engage in research, innovation, lifelong learning and continued professional development.*
- *To fulfill professional ethics and social responsibilities.*

Bharati Vidyapeeth Deemed to be University, Pune

Faculty of Engineering & Technology

Programme : B.Tech (Robotics & Automation Engineering) Sem – I (2020 Course)

Sr. No.	Category of Courses	Name of Course	Teaching Scheme			Examination Scheme						Credits				
			L	P	T	ESE	Continuous Assessment	Practical			Total	Theory	TW	OR	PR	Total
								TW	OR	PR						
1	BSC	Engineering Mathematics – I	3	--	1	60	40	--	--	--	100	4	--	--	--	4
2	ESC	Engineering Graphics	4	2	--	60	40	25	--	--	125	4	1	--	--	5
3	BSC	Engineering Physics	3	2	--	60	40	25	--	--	125	3	1	--	--	4
4	PCC	Fundamentals of Electrical Engineering	4	2	--	60	40	25	--	25	150	4	0.5	--	0.5	5
5	ESC	Engineering Mechanics	3	2	--	60	40	25	25	--	150	3	0.5	0.5	--	4
6	HSMC	Open Course 1 (Business communication)	2	--	--	50	--	--	--	--	50	2	--	--	--	2
7	ESC	Workshop Technology	--	2	--	--	--	50	--	--	50	--	1	--	--	1
		Total	19	10	1	350	200	150	25	25	750	20	4	0.5	0.5	25

Programme : B.Tech (Robotics & Automation Engineering) Sem – II (2020 Course)

Sr. No.	Category of Courses	Name of Course	Teaching Scheme			Examination Scheme						Credits				
			L	P	T	ESE	Continuous Assessment	Practical			Total	Theory	TW	OR	PR	Total
								TW	OR	PR						
8	BSC	Engineering Mathematics – II	3	--	1	60	40	--	--	--	100	4	--	--	--	4
9	PCC	Electronic Devices & Circuits	3	2	--	60	40	25	--	--	125	3	1	--	--	4
10	BSC	Engineering Chemistry	3	2	--	60	40	25	--	--	125	3	1	--	--	4
11	PCC	Electrical & Electronic Measurement techniques	3	2	--	60	40	25	--	--	125	3	1	--	--	4
12	PCC	Fundamentals of design & manufacturing engineering	3	2		60	40	25	--	--	125	3	1	--	--	4
13	PCC	Problem Solving with Simulation & Programming	--	4	--	--	--	50	--	--	50	--	2	--	--	2
14	HSMC	Open Course 2	2	--	--	50	--	--	--	--	50	2	--	--	--	2
15	SBC	Production Practices	--	2	--	--	--	50	--	--	50	--	1	--	--	1
		Total	17	12	1	350	200	200	--	--	750	18	6.5	--	0.5	25

Total Credits Sem – I : 25
Total Credits Sem – II : 25
Grand total : 50

B. Tech. (Robotics &Automation) Sem.-III

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)				Examination Scheme (Marks)					Credits			
			L	P	T	ESE	IA	TW	OR	PR	Total	L	P	T	Total
1	25352	Hydraulics & Pneumatics: Principals	4	2	-	60	40	25	25	-	150	4	1	-	5
2	25353	Theory of Machines	4	2	-	60	40	25	25	-	150	4	1	-	5
3	25354	Strength of Machine Components	4	0	1	60	40	-	-	-	100	4	-	1	5
4	25355	Electronic Circuits	3	0	-	60	40	-	-	-	100	3	-	-	3
5	25356	Embedded Systems[@]	3	2	-	60	40	25#	-	-	125	3	1	-	4
6	25357	Data Structures and Algorithms	-	2	-	-	-	25#			25		1	-	1
7	25358	MATLAB Programming	-	2	-	-	-	25	-	25	50	-	1	-	1
8	25359	Vocational Course-I [$]	-	2	-		-	25	25	-	50	-	1	-	1
	Total		**18**	**12**	**1**	**300**	**200**	**150**	**75**	**25**	**750**	**18**	**6**	**1**	**25**
9		Social Activity-I [**]	-	-	-	--	-	-	-	-	-	-	-	-	2

#: Based on TW & internal oral examination; [@]Industry Taught Course-I; $ Sensors, PLC & HMI: Basic Training;** Add on Course,

B. Tech. (Robotics &Automation) Sem.-IV

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	OR	PR	Total	L	P	T	Total
1	25825	Digital Electronics[@]	4	-	-	60	40	-	-	-	100	4	-	-	4
2	25826	Power Electronics & Drives	3	2	1	60	40	25	25	-	150	3	1	1	5
3	25827	Manufacturing Technology-I	3	2	-	60	40	25	-	-	125	3	1	-	4
4	25828	Automatic Control Systems	4	2	-	60	40	25	25	-	150	4	1	-	5
5	25829	Design & Analysis of Machine Components*	4	2	-	60	40	25	25	-	150	4	1	-	5
6	25830	Solid Modelling	-	2	-	-	-	25	-	-	25		1	-	1
7	25831	Vocational Course-II [$]	-	2	-	-	-	25	25	-	50	-	1	-	1
	Total		**18**	**12**	**1**	**300**	**200**	**150**	**100**	**00**	**750**	**18**	**6**	**1**	**25**
8		MOOC-I**	-	-	-	-	-	-	-	-	-	-	-	-	2

#: Based on TW & internal oral examination; [@]Industry Taught Course-II; $ PLC, HMI & Automation: Advanced Training; ** Add on Course

B. Tech. (Robotics &Automation) Sem.-V

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	OR	PR	Total	L	P	T	Total
1	24794	Signals and Systems[@]	4	2	-	60	40	25#	-	--	125	4	1	-	5
2	24795	Robot Kinematics & Dynamics	3	2	1	60	40	25	25	-	150	3	1	1	5
3	24796	Manufacturing Technology-II	4	2	-	60	40	25	25	-	150	4	1	-	5
4	24797	Electrical Control Systems	3	2	-	60	40	25#	-	-	125	3	1	-	4
5	24798	Introduction to Finite Element Analysis*	4	2	-	60	40	25	-	25	150	4	1	-	5
6	24799	Vocational Course-III[$]	-	2	-	-	-	25	25	-	50	-	1	-	1
	Total		**18**	**12**	**1**	**300**	**200**	**150**	**75**	**25**	**750**	**18**	**6**	**1**	**25**
7		Environmental Study+	2	-	-	50	-	-	-	-	50	-	-	-	-
8		Social Activity-II [**]	-	-	-	--	-	-	-	-	-	-	-	-	2

#: Based on TW & internal oral examination ; [@]Industry Taught Course-III; $ Mounting and Communication of Sensors; +Mandatory Audit course; ** Add on Course

B. Tech. (Robotics &Automation) Sem.-VI

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	OR	PR	Total	L	P	T	Total
1	24802	Electro Hydraulics and Pneumatics[@]	4	2	-	60	40	25	25	-	150	4	1	-	5
2	24803	Robotic Simulation	3	2	-	60	40	25#	-	-	125	3	1	-	4
3	24804	Instrumentation for Robotics & Automation	4	2	-	60	40	25	25	-	150	4	1	-	5
4	24805	Quantitative Techniques, Communication and Values	3	-	-	60	40	-	-	-	100	3	-	-	3
5	24806	Artificial Intelligence and Neural network for Robots	3	-	1	60	40	25#	-	-	125	3	-	1	4
6	24807	Vocational Course-IV[$]	-	2	-	-	-	25	25	-	50	-	1	-	1
7	24808	Robotic Programming-I	2	2	-	-	-	25	-	25	50	2	1	-	3
	Total		**19**	**10**	**1**	**300**	**200**	**150**	**75**	**25**	**750**	**19**	**5**	**1**	**25**
8		MOOC-II**	-	-	-	-	-	-	-	-	-	-	-	-	2

#: Based on TW & internal oral examination ; [@]Industry Taught Course-IV; $ Troubleshooting and Maintenance of Robots; ** Add on Course

B. Tech. (Robotics &Automation) Sem.-VII

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	OR	PR	Total	L	P	T	Total
1		Advanced Robotics	3	2	1	60	40	25	25	-	150	3	1	1	5
2		Elective-I	3	2	-	60	40	25	-	-	125	3	1	-	4
3		Industrial Internet of Things	4	2	-	60	40	25	25	-	150	4	1	-	5
4		Future Factory (FMS)[@]	3	2	-	60	40	25#	-	-	125	3	1	-	4
5		Robotic Programming-II		2	-	-	-	25	25	-	50	-	1	-	1
6		Project Stage-I	-	2	-	-	-	50	50	-	100	-	3	-	3
7		Internship***	-	-	-	-	-	25	25	-	50	-	3	-	3
	Total		**13**	**12**	**1**	**240**	**160**	**200**	**150**	**-**	**750**	**13**	**11**	**1**	**25**

#: Based on TW & internal oral examination ; [@]Industry Taught Course-V; *** Period of 60 days

B. Tech. (Robotics & Automation) Sem.-VIII

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	OR	PR	Total	L	P	T	Total
1		Totally Integrated Automation	4	2	-	60	40	25	-	-	125	4	1	-	5
2		Elective-II	3	2	-	60	40	25	-	-	125	3	1	-	4
3		Industrial Engineering & Management	3	-	-	60	40	-	-	-	100	3	-	-	3
4		Field & Service Robots[@]	3	-	1	60	40	-	-	-	100	3	-	1	4
5		Mobile Robots & Drone Technology	-	2	-	-	-	25	25	-	50	-	1	-	1
6		Design of Integrated Robotic Cells	-	4	-	-	-	25	25	-	50	-	2	-	2
7		Project Stage-II	-	4	-	-	-	100	100	-	200	-	6	-	6
	Total		**13**	**14**	**1**	**240**	**160**	**200**	**150**	**-**	**750**	**13**	**11**	**1**	**25**
8		Research Paper Publication**	-	-	-	-	-	-	-	-	-	-	-	-	2

#: Based on TW & internal oral examination ; [@]Industry Taught Course-VI, Social Activities-Additional Credit Course; ** Add on Course

Elective-I: Six Sigma, Lean & Agile Manufacturing, Engineering Economics, Augmented Reality & Virtual Reality, Operations Research Elective-II: Industrial Product Design, Project Management & Ethics, Additive Manufacturing & Rapid Prototyping, Image Processing

Head
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B.V.D.U., College of Engineering
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BHARATI VIDYAPEETH (DEEMED TO BE UNIVERSITY) (INDIA) ,PUNE

B. Tech (Robotics & Automation) Sem-I

ENGINEERING MATHEMATICS- I

Designation: Professional Core

Course Pre-requisites:

Students should have knowledge of

1.	Basic Mathematics

Category : BSC Code: KGAU11

TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Lectures : 4 Hours/Week	End Semester Examination : 60 Marks	Theory : 04
Tutorial : 1 Hour /Week	Unit Test : 40 marks	Tutorial : 01
	Total : 100 Marks	Total credits : 05

Course Outcomes:

After completion of the course students will be able to

1.	To solve linear equations and calculate Eigen values, Eigen Vectors.
2.	Apply theorem to find roots of algebraic equations
3.	To solve differential Calculus by expansion of functions.
4.	To solve differential Calculus by infinite series.
5.	Apply partial differentiation theorems on Homogeneous Functions
6.	Find Maxima and Minima of Functions of two variables.

Topics covered

UNIT - I	**Matrices** Rank, Normal form, System of Linear Equations, Linear Dependence and Independence, Linear and Orthogonal Transformations. Eigen values, Eigen Vectors, Cayley – Hamilton Theorem.Application to problems in Engineering.	**(08 Hours)**
UNIT - II	**Complex Number and Its Applications** Definition, Cartesian, Polar and Exponential Forms ,Argand's Diagram, De'Moivre's theorem and its application to find roots of algebraic equations., Hyperbolic Functions, Logarithm of Complex Numbers, Separation into Real and Imaginary parts, Application to problems in Engineering.	**(08 Hours)**
UNIT - III	**Differential Calculus** Successive Differentiation, nth Derivatives of Standard Functions,Leibnitz's Theorem. **Expansion of Functions** Taylor's Series and Maclaurin's Series	**(08 Hours)**
UNIT - IV	**Differential Calculus** Indeterminate Forms, L' Hospital's Rule, Evaluation of Limits. **Infinite Series** Infinite Sequences, Infinite Series, Alternating Series, Tests for Convergence,	**(08 Hours)**

	Absolute and Conditional Convergence, Power series, Range of Convergence.	
UNIT - V	**PARTIAL DIFFERENTIATION AND APPLICATIONS** Partial Derivatives, Euler's Theorem on Homogeneous Functions, Implicit functions, Total Derivatives, Change of Independent Variables. Errors and Approximations.	**(08 Hours)**
UNIT - VI	**JACOBIAN** Jacobians and their applications, Chain Rule, Functional Dependence. **MAXIMA AND MINIMA** Maxima and Minima of Functions of two variables, Lagrange's method of undetermined multipliers.	**(08 Hours)**

Text Books/ References:	
1.	Applied Mathematics (Volumes I and II) by P. N. Wartikar& J. N. Wartikar, Pune VidyarthiGrihaPrakashan, Pune, 7th edition (1988).
2.	Higher Engineering Mathematics by B. S. Grewal, Khanna Publication, Delhi, 42th edition (2012).
3.	Higher Engineering Mathematics by B.V. Ramana, Tata McGraw-Hill (2008) .
4.	Advanced Engineering Mathematics by Erwin Kreyszig, Wiley Eastern Ltd, 8^{th} edition (1999).
5.	Advanced Engineering Mathematics, 7e, by Peter V. O'Neil, Thomson Learning,6th edition (2007).
6.	Advanced Engineering Mathematics, 2e, by M. D. Greenberg, Pearson Education, 2nd edition (2002).

ENGINEERING GRAPHICS

Designation of Course	**ENGINEERING GRAPHICS**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory :- 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical :- 02 Hours/ Week	Unit Test	40 Marks	
	Term Work	25 Marks	01
	Oral/~~Practical~~	--	--
	Total	125 Marks	05

Course Prerequisites:-	Knowledge of basic geometry
Course Outcomes:-	1. Different engineering curves and dimensioning. 2. Differentiate Ist angle and IIIrd angle projection Method in orthographic. 3. To interpret views of the object and to draw by using Isometric projection method. 4. Projection of Lines, its traces and planes. 5. Projection of different solids. 6. Development of lateral surfaces of solids.

Course Contents

Unit 1	**Lines and Dimensioning in Engineering Drawing and Engineering Curves**	(08 Hrs.)

Different types of lines used in drawing practice, Dimensioning – linear, angular, aligned system, unidirectional system, parallel dimensioning, chain dimensioning, location dimension and size dimension.

Ellipse by Arcs of Circle method, Concentric circle method. Involutes of a circle, Cycloid, Archimedean Spiral, Helix on cone & cylinder.

Introduction to Auto CAD commands.

Unit 2	**Orthographic Projection**	(08 Hrs.)

Basic principles of orthographic projection (First and Third angle method). Orthographic projection of objects by first angle projection method only. Procedure for preparing scaled drawing, sectional views and types of cutting planes and their representation, hatching of sections.

(Also using AutoCAD commands)

Unit 3	**Isometric Projections**	(08 Hrs.)

Isometric view, Isometric scale to draw Isometric projection, Non-Isometric lines, and construction of Isometric view from given orthographic views and to construct Isometric view.

(Also using AutoCAD commands)

Unit 4	**Projections of Points, Lines and Planes**	(08 Hrs.)

Projections of points, projections of lines, lines inclined to one reference plane, Lines inclined to both reference

planes. (Lines in First Quadrant Only) Traces of lines,

Projections of Planes, Angle between two planes, Distance of a point from a given plane, Inclination of the plane with HP, VP.

(Also using AutoCAD commands)

Unit 5	**Projection of Solids**	(08 Hrs.)
Projection of prism, pyramid, cone and cylinder by rotation method. (Also using AutoCAD commands)		
Unit 6	**Development of Lateral Surfaces (DLS) of Solids.**	(06 Hrs.)
Introduction to development of lateral surfaces and its Industrial application, draw the development of lateral surfaces of cone, pyramid and prism. (Also using AutoCAD commands)		

Term work

Term work shall consist of half imperial size or A2 size (594 mm x 420 mm) sheets.

All sheets should complete in drawing hall manually and sheet no 2-7 also completed using AutoCAD with printout on A2 size papers.

Sheets

1. Types of lines, Dimensioning practice, free hand lettering, 1ndand 3rd angle methods symbol.
2. Engineering curves.
3. Orthographic Projections.
4. Isometric views.
5. Projections of Points and Lines and planes.
6. Projection of Solids.
7. Development of lateral surfaces.

Text Books/ Reference Books

1. "Elementary Engineering Drawing", N.D. Bhatt, Charotar Publishing house, Anand India,
2. "Text Book on Engineering Drawing", K.L.Narayana & P.Kannaiah, Scitech Publications, Chennai.
3. "Fundamentals of Engineering Drawing", Warren J. Luzzader, Prentice Hall of India, New Delhi ,
4. "Engineering Drawing and Graphics", Venugopal K., New Age International publishers.
5. M. B. Shah and B. C. Rana, "Engineering Drawing", 1st Ed, Pearson Education, 2005
6. P. S. Gill, "Engineering Drawing (Geometrical Drawing)", 10 Edition, S. K. Kataria and Sons, 2005
7. P. J. Shah, "Engineering Drawing", C. Jamnadas and Co., 1 Edition, 1988

B. Tech (Robotics & Automation)
ENGINEERING PHYSICS

Designation of Course	**Engineering Physics**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 3 Hours/ Week	End Semester Examination	60 Marks	Theory: 03 Tutorial: 00 Practical: 01
Tutorial : 00 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	
	Oral/Practical Examination	-- Marks	
	Total	125 Marks	4
Course Prerequisite:-	Students are expected to have a basic understanding of physics and calculus.		
Course Objective	After completing this course the students will able to apply knowledge of Engineering Physics to different branches of engineering for better conceptual clarity and exploring emerging fields of technology and research.		
Course Outcomes:-	1. Interpret the basics of semiconductors and its uses to develop electronics devices such as diode. 2. Interpret the properties of lasers and use it to applications like fibre optics and holography. 3. Express knowledge of nanoscience to develop new electronic devices. 4. Interpret the magnetic properties of material. 5. Express the properties of new engineering materials such as shape memory alloys. 6. Analyze the problems associated with architectural acoustics and give their remedies and use ultrasonic as a tool in industry for Non Destructive Testing. Define the behavior of quantum particles in different potentials.		

Course Contents

Unit 1	Semiconductor Physics	**(6Hrs.)**
Free electron theory, Density of states, Bloch theorem (Statement only), Origin of band gap, Energy bands in solids, Effective mass of electron, Fermi-Dirac probability function and position of Fermi level in intrinsic semi-conductors (with derivation) and in extrinsic semi-conductors, Band structure of p-n junction diode under forward and reverse biasing, Conductivity in conductor and semi-conductor, Hall effect and Hall coefficient, Photovoltaic effect, Solar cell and its characteristics.		
Unit 2	Lasers and Fibre Optics	**(6Hrs.)**
Principle of laser, Einstein's coefficients, Spontaneous and stimulated emission, Population inversion, Ruby laser, Helium-Neon laser, Semiconductor laser, Properties of lasers, Applications of lasers (Engineering/ industry, medicine, communication, Computers), Holography. Principle and structure of optical fibre, acceptance angle and acceptance cone, numerical aperture, Applications of optic fibre.		
Unit 3	Nanoscience	**(6Hrs.)**
Introductions of nanoparticals, properties of nanoparticals (Optical, electrical, Magnetic, structural, mechanical), Wide band gap semiconductors, Quantum confinement effect, Quantum dots, CNT, Fullerene, synthesis of nanoparticals, synthesis of nanoparticals by physical-ball milling and chemical-co-precipitation, applications in the field of electronics, automobile and medicine.		
Unit 4	Magnetic Materials and Superconductors	**(6Hrs.)**
Origin of magnetic moment , Bohr magneton, Domain theory, comparison of Dia, Para and Ferro magnetism, Hysteresis – soft and hard magnetic materials, antiferromagnetic materials, Ferrites and its applications. Superconductors, properties, Meissner effect, Type I and Type II superconductors, BCS theory of superconductivity (Qualitative) - High Tc superconductors – Applications of superconductors – SQUID, cryotron, magnetic levitation.		
Unit 5	Advance Engineering Materials	**(6Hrs.)**
Metallic glasses: preparation, properties and applications. Shape memory alloys (SMA): Characteristics, properties of NiTi alloy, application, Nanomaterials– Synthesis by pulsed laser deposition and chemical vapour deposition, Applications, NLO materials. Birefringence, optical Kerr effect, Classification of Biomaterials and its applications		
Unit 6	Acoustics and Ultrasonics	**(6Hrs.)**
Elementary acoustics, Reverberation and reverberation time, Sabine's formula, Pressure and Intensity level, different types of noise and their remedies, basic requirement for acoustically good hall, factors affecting the architectural acoustics and their remedies. Production of ultrasonics by magnetostriction and piezoelectric methods - acoustic grating –Non Destructive Testing – pulse echo system through transmission and reflection modes - A,B and C–scan displays, Medical applications - Sonogram		

Text Books/ Reference Books

1. Engineering Physics, M. N. Avadhanulu and P.G. Kshirsagar, Engineering Physics, S Chand Publication, 9th Edition, 2011.
2. Engineering Physics, R. K. Gaur and S. L. Gupta, Dhanpat Rai Publications.
3. Fundamental of Physics Extended, Halliday and Resnik, Wiley Publication, 10th Edition, 2013.
4. Concept of Modern Physics, Arthur Beizer, McGraw Hill Publication, 6th Edition, 2003.
5. Optics, Ajoy Ghatak, McGraw Hill Publication, 5th Edition, 2012.
6. Science of Engineering Materials, C.M. Srivastava and C. Srinivasan, Wiley Publication.
7. Solid State Physics, A.J. Dekker, Pan MacMillan Publication, 1969.

TERM WORK

Experiments Any eight experiments from the following:

1. Determination of band gap of semi-conductor.
2. Solar cell characteristics.
3. e/m by Thomson's method.
4. Uses of CRO for measurement of phase difference and Lissajos figures.
5. Hall effect and Hall coefficient.
6. Conductivity by four probe method.
7. Diode characteristics (Zener diode, Photo diode, LED, Ge/Si diode).
8. Plank's constant by photodiode.
9. Wavelength by diffraction grating.
10. Wavelength of LASER by diffraction grating.
11. Newton's rings.
12. Ultrasonic interferometer.
13. Sound intensity level measurement.
14. Wavelength of laser by diffraction.
15. Determination of refractive index for O-ray and E-ray.
16. Brewester's law.
17. Synthesis of ZnO nanoparticles by chemical method
18. Laser divergence angle
19. Determination of band gap of synthesized nanoparticles
20. Project based Learning
21. Project based Learning

Assignments:

At least ONE assignment on each unit

B. Tech (Electrical)- Sem-I

FUNDAMENTALS OF ELECTRICAL ENGINEERING		
Designation: Breadth		
Course Pre-requisites:		
1.	Students should have basic knowledge of Physics and Mathematics	
TEACHING SCHEME:		**EXAMINATION SCHEME:**
Lectures: 04 Hours / Week		End Semester Examination : 60 Marks
Practical: 02 Hours / Week		Continuous Assessment : 40 Marks
		Term Work: 25 Marks Practical: 25 Marks
Course Outcomes:		
The students will be able to		
1.	Understand the basic laws and theorems in DC circuits	
2.	Understand concept of phasors and fundamentals of single phase AC circuits	
3.	Interpret the basics of three phase AC circuits and relationships for voltages and currents in star and delta connected systems	
4.	Understand the basic concepts of series and parallel magnetic circuits and single phase transformer	
5.	Classify high conductivity, magnetic and insulting materials.	
6.	Understand causes and effects of electrical hazards, earthing system and IS standards	
Topics covered		
UNIT - I	**DC Circuit Analysis and Network Theorems:** Circuit Concepts: Concepts of network, Active and passive elements, voltage and current sources, concept of linearity and linear network, unilateral and bilateral elements, R, L and C as linear elements, source transformation. Kirchhoff's laws; loop and nodal methods of analysis; star-delta transformation; Network Theorems: Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem (simple numerical problems).	**(08 Hours)**
UNIT - II	**Steady- State Analysis of Single Phase AC Circuits:** AC Fundamentals: Sinusoidal, square and triangular waveforms – average and effective values, form and peak factors, concept of phasors, phasor representation of sinusoidally varying voltage and current. Analysis of series, parallel and series-parallel RLC Circuits: apparent, active & reactive powers, power factor, causes and problems of low power factor, power factor improvement; resonance in series and parallel circuits, bandwidth and quality factor (simple numerical problems).	**(08 Hours)**
UNIT -III	**Three Phase AC Circuits:** Three phase system-its necessity and advantages, meaning of phase sequence, star and delta connections, balanced supply and balanced load, line and phase voltage/current relations, three-phase power and its measurement (simple numerical problems).	**(08 Hours)**
UNIT -IV	**Magnetic Circuit:** flux, flux density, field strength, analogy between electric & magnetic circuits, magnetic circuits with DC and AC excitations, magnetic leakage, B-H curve, hysteresis and eddy current losses, magnetic circuit calculations, mutual coupling. **Electromagnetic Induction:** Faraday's Law of EMI, Induced EMF, Lenz's Law, Self Inductance, Coefficient of Self inductance (L), Mutual inductance, Coefficient of Mutual inductance (M), self induced EMF and mutually induced EMF,	**(08 Hours)**

	Coefficient of Coupling, Inductance in series, Types of inductor, their application and Energy Stored in Magnetic Field	
UNIT -V	**Electrical Engineering Materials** High conductivity materials (Copper, Aluminium, Steel, Iron, alloys of copper), materials used in precision work, magnetic materials and its classification, insulating materials: electrical properties, temperature rise and classification. Dielectric and optical properties of materials, nano-materials.	**(08 Hours)**
UNIT-VI	**Electrical Hazards and safety:** Electrical Hazards: Hazards of electrical energy. Safe limits of amperages, voltages. Safe distance from lines. Capacity and protection of conductor. Joints and connections. Means of cutting off power, Earth insulation and continuity tests. Earthing: Types & Standards. Protection against surge and voltage fluctuation. Hazards arising out of 'borrowed' neutrals. Others precautions. Types of protection for electrical equipment in hazardous atmosphere. Electrical area classification. Criteria in their selection, installation, maintenance and use, IS standards (IS: 5216(Part-1)-1982)for electrical safety. Electricity bill, Tariff and its types.	**(08 Hours)**

List of Practicals to be performed in the laboratory:

1.	Plotting B-H characteristics for a material
2.	Study of R-L series, R-C series , R-L-C series circuit
3.	Time response of R-L series and R-C series circuit
4.	Verification of voltage and current relationships in star and delta connected 3-phase networks
5.	Load test on DC machine
6.	Single lamp controlled by two different switches(staircase)
7.	Two lamps controlled independently from two different switches (parallel)
8.	Series connected lamps
9.	Go-down wiring
10.	Study of Electricity bill(Industrial / commercial)
11	Load test on induction motor
12	To find efficiency and regulation of single phase transformer
13	To find the polarity of a 3-phase transformer

Note:
The term work shall be the record of minimum eight experiments performed from the above list.

Reference Books:

1.	Electrical Technology - Edward Huges (Pearson)
2.	Basic Electrical Engineering - D. P. Kothari, J Nagarath (TMC)
3.	Electrical power system technology - S. W. Fordo, D. R. Patric (Prentice Hall)
4.	Principles of Electronics-Dr. H. M. Rai (SatyaPrakashan)
5.	Electronic Devices and Circuit Theory- R. L. Boylestad and L. Nashelsky (PHI)
6.	Electrical, Electronics Measurements and Instruments - (SatyaPrakashan)
7.	Principles of Communication Engineering - Anokh Singh, A. K. Chhabra (S Chand)

Engineering Mechanics

TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Theory: 03 Hours / Week	End Semester Examination: 60 Marks Continuous Assessment: 40 Marks	Credits : 03
Practical: 02 Hours / Week	Term Work: 25 Marks Oral: 25 Marks	Credits: 01

Course Pre-requisites: The students should have knowledge of

1	Physics-Forces, Newton's law of motion, Concept of physical quantities, their units and conversion of units, Scalar and Vector
2	Mathematics-Algebra, Geometry, Concept of differentiation and integration

Course Objectives:

	The student should be able to determine effect of forces on rigid object to solve engineering problems.

Course Outcomes: The student will be able to

1	calculate resultant and apply conditions of equilibrium.
2	calculate friction force and its effect.
3	analyze the truss
4	calculate centroid and moment of inertia.
5	evaluate kinematic effect of forces
6	evaluate kinetic effect of forces

Course Content:

UNIT - I	**Resultant and Equilibrium** Types and Resolution of forces, Moment and Couple, Free Body Diagram, Types of Supports, Classification and Resultant of a force system in a Plane - Analytical and Graphical approach.. Equilibrant, Conditions of Equilibrium, Equilibrium of a force system in a Plane, Force and Couple system about a point.	**(06 Hours)**
UNIT - II	**Friction** Coefficient of Static Friction, Impending motion of Blocks, Ladders and Belts.	**(06 Hours)**
UNIT - III	**Analysis of Truss** Analysis of Perfect Trusses - Method of Joint, Method of Section and Graphical Method.	**(06 Hours)**
UNIT - IV	**Centroid and Moment of Inertia** Centroid of line and plane areas, Moment of Inertia of plane areas, parallel and perpendicular axis theorem, radius of gyration, least moment of inertia.	**(06 Hours)**
UNIT - V	**Kinematics of a Particle** Cartesian components, Normal and Tangential components of motion, Relative motion, Dependent motion, Motion of a Projectile,	**(06 Hours)**
UNIT - VI	**Kinetics of a Particle** D'Alemberts Principle, Work-Energy Principle and Impulse-Momentum Principle, Coefficient of Restitution, Direct Central Impact.	**(06 Hours)**

Term Work:

Part- A	The term-work shall consist of minimum **Five** experiments from list below.	
	1) Study of equilibrium of concurrent force system in a plane	
	2) Determination of reactions of Simple and Compound beam.	
	3) Determination of coefficient of friction for Flat Belt.	
	4) Determination of coefficient of friction for Rope.	
	5) Determination of Centroid of line or plane elements.	
	6) Study of Curvilinear motion.	
	7) Determination of Coefficient of Restitution.	
Part- B	The term-work shall also consist of minimum **Five** graphical solutions of the problems on	

	different topics.	

Text Books:
Engineering Mechanics (Statics and Dynamics)",Hibbeler R.C., McMillan Publication
Vector Mechanics for Engineers-Vol.-I and Vol.-II (Statics and Dynamics)", Beer F.P. and Johnston E.R., Tata McGraw Hill Publication.
Engineering Mechanics",Bhavikatti S.S. and Rajashekarappa K.G., New Age International (P) Ltd.
Reference Books:
"Engineering Mechanics (Statics and Dynamics)", Shames I.H., Prentice Hall of India (P) Ltd.
"Engineering Mechanics (Statics and Dynamics)", Singer F.L., Harper and Row Publication
Engineering Mechanics (Statics and Dynamics)",Meriam J.L. and Kraige L.G., John Wiley and Sons Publication
"Engineering Mechanics (Statics and Dynamics)",Timoshenko S.P. and Young D.H., McGraw Hill Publication
"Engineering Mechanics (Statics and Dynamics)",Tayal A.K., Umesh Publication
"Engineering Mechanics-I and II (Statics and Dynamics)", Mokashi V.S., Tata McGraw Hill Publication

Business Communication
(All branches) Sem-I

Designation of Course	**Business Communication**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 2 Hours/ Week	End Semester Examination	50 Marks	Theory: 02 Tutorial: 00 Practical: 00
Tutorial : 00 Hours/ Week	Internal Assessment	00 Marks	
	Term Work	00 Marks	
	Oral/Practical Examination	00 Marks	
	Total	60 Marks	2
Course Prerequisites:-	Students should have knowledge of Basic English grammar Students should have basic information of sound system of English language Basics of written communication		
Course Objective	The course objective of Business Communication is to help students understand the basic of English language through application of it in business. The units cover the aspects of functional grammar for inculcating the basics for business communication. It helps students to understand the process of communication in association with different components of communication. It also targets the understanding of different barriers that creep into communication process and different business documentation process.		
Course Outcomes:-	Graduates will able to 01. To construct the error free sentences of English language and do implementation of it in the spoken and written business communication 02. Do applications of sounds of English language for correct pronunciation 03. To understand communication process and principles to do applications in business communication 04. Develop the ability to communicate effectively using suitable styles and techniques of communication 05. Build up the ability to study employment business communication skills and its proper implications 06. To construct effective business presentation and do effective implementation of it through activities		

Course Contents

Unit 1	English grammar:	**(4 Hrs.)**
Forms of tense, articles, preposition, use of auxiliaries and modal auxiliaries, common errors, Vocabulary development through GRAPS-PT, types of sentences voice, direct indirect speech, degree of comparison		
Unit 2	Phonetics/study of sounds in English:	**(4Hrs.)**
Introduction to phonetics, study of speech organs, study of phonetic script, transcriptions of words, articulation of different sound in English, reducing MTI, stress and intonation		

Unit 3	**Communication Skills**	**(4Hrs.)**
Introduction, forms and function of communication process, non-verbal codes in communication, importance of LSRW in communication, Barriers to communication and overcoming them digital communication		
Unit 4	**Mechanics of Written Communication**	**(4Hrs.)**
Developing the mechanics of written communication: principles of effective writing, technical report writing; format, structure and its types, language development through literary text		
Unit 5	Honing employment communication:	**(4Hrs.)**
Job application, building resume and CV, email writing, group discussion, interview skills, meeting formation, notice, agenda, minutes of meeting		
Unit 6	esentation skills:	**(4Hrs.)**
Designing effective presentation, understanding theme, developing content and layout of presentation, use of tone and language, technological tools for effective presentation, developing content for extempore, elocution and public speaking		

Reference Books:

1. Business Communication by Meenakshi Raman, Prakash Singh published by Oxford University press, second edition,
2. Spoken English- A manual of Speech and Phoonetics by R. K. Bansal, J. B. Harrison published by Orient Blackswan
3. Communication Skills by Sanjay Kumar, Pushp Lata, published by Oxford University press, second edition
4. Technical Communication by Meenakshi Raman, Sangeeta Sharma published by Oxford University press
5. Developing Communication Skills by Krishna Mohan, Meera Banerji published by Macmillan India Pvt Ltd

Recommended web-links for enhancing English language and business communication

1. http://www.bbc.co.uk/worldservice/learningenglish
2. http://www.englishlearner.com/tests/test.html
3. http://www.hodu.com/default.html
4. http://www.communicationskills.co.in/index.html

Assignments: At least ONE assignment on each unit

Syllabus for Robotics and Automations

Workshop

TEACHING SCHEME: EXAMINATION SCHEME: CREDITS ALLOTTED:

Practical: --2 Hrs/Week TW : 25 Marks 01 Credits

Pre-requisites: Basics of physics ,chemistry , mathematics and measurements.

Course Outcomes:

· To develop a skill in dignity of labour, precision, safety at workplace, team working and development of right attitude.

· To acquire skills in basic engineering practice

· To identify the hand tools and instruments

· To develop general machining skills in the students

Course Objectives

Student Should be able to,

1) Understand the Measuring and Marking systems used in Carpentry Work.

2) Understand the Hot working Processes.

3) Understand the Techniques of Welding.

4) Understand the Machine tools, Mechanisms and Drilling operations.

Instruction and Demonstration: Instruction should be given for each of following shops which include importance of the shop in engineering, new materials available, use of each tool / equipment, methods of processing any special machines, power required etc.

Four Sections

Section 1 – Carpentry (Two Practical's on Pattern making Carpentry Batch Job)

Study of tools & operations and carpentry joints, Simple exercise using jack plane, Simple exercise on woodworking lathe.

Section 2 – Black Smithy and Tin Smithy (3 Practicals on Black Smithy and Tin Smithy-Batch Job)

Study of tools & operations, Simple exercises base on smithy operations such as upsetting, drawing down, punching, bending, fullering & swagin

Section 3 – Welding Processes. (Two Practical's on Welding batch Job)

Study of tools & operations of Gas welding & Arc welding, Simple butt and Lap welded joints, Oxy-acetylene flame cutting.

Section 4 – Machining Processes (Making Batch Job on Lathe Machine And Millng Grinding Process 4 practical)

Study of machine tools and operations, Demonstrations of basic machine tools like Lathe, Shaper, drilling machine with basic operations etc

ENGINEERING MATHEMATICS- II					
Designation: Professional Core					
Course Pre-requisites:					
Students should have knowledge of					
1.	Basic Mathematics				
Category : BSC				Code: KGAU11	
TEACHING SCHEME:		**EXAMINATION SCHEME:**		**CREDITS ALLOTTED:**	
Lectures	: 4 Hours/Week	End Semester Examination	: 60 Marks	Theory	: 04
Tutorial	: 1 Hour /Week	Unit Test	: 40 marks	Tutorial	: 01
		Total	: 100 Marks	Total credits	: 05

Course Outcomes:	
After completion of the course students will be able to	
1.	To solve differential equations by different methods
2.	Apply different laws to solve Simple Harmonic Motion, One–Dimensional Conduction of Heat, Chemical engineering problems.
3.	To solve integral calculus and Fourier series
4.	To solve integral calculus with error functions
5.	Draw solid geometry.
6.	Solve multiple integration problems.

Topics covered

UNIT - I	**DIFFERENTIAL EQUATIONS (DE)** Definition, Order and Degree of DE, Formation of DE. Partial Differential Equations, Classification of higher order PDEs. Solutions of Variable Separable DE, Exact DE, Linear DE and reducible to these types.	**(08 Hours)**
UNIT - II	**APPLICATIONS OF DIFFERENTIAL EQUATIONS** Applications of DE to Orthogonal Trajectories, Newton's Law of Cooling, Kirchoff's Law of Electrical Circuits, Motion under Gravity, Rectilinear Motion, Simple Harmonic Motion, One–Dimensional Conduction of Heat, Chemical engineering problems. Solution of Higher order ODE with constant and variable coefficients and its applications to boundary and initial value problems	**(08 Hours)**
UNIT - III	**FOURIER SERIES** Definition, Dirichlet's conditions, Fourier Series and Half Range Fourier Series, Harmonic Analysis. **INTEGRAL CALCULUS** Reduction formulae, Beta and Gamma functions.	**(08 Hours)**
UNIT - IV	**INTEGRAL CALCULUS** Differentiation Under the Integral Sign, Error functions. **CURVE TRACING** Tracing of Curves, Cartesian, Pola and Parametric Curves. Rectification of Curves.	**(08 Hours)**

UNIT - V	**SOLID GEOMETRY** Cartesian, Spherical Polar and Cylindrical Coordinate Systems. Sphere, Cone and Cylinder.	**(08 Hours)**
UNIT - VI	**MULTIPLE INTEGRALS AND THEIR APPLICATIONS** Double and Triple integrations, Applications to Area, Volume, Mean and Root Mean Square Values.	**(08 Hours)**
Text Books/ References:		
1.	Applied Mathematics (Volumes I and II) by P. N. Wartikar& J. N. Wartikar, Pune VidyarthiGrihaPrakashan, Pune, 7th edition (1988).	
2.	Higher Engineering Mathematics by B. S. Grewal, Khanna Publication, Delhi, 42th edition (2012).	
3.	Higher Engineering Mathematics by B.V. Ramana, Tata McGraw-Hill (2008) .	
4.	Advanced Engineering Mathematics by Erwin Kreyszig, Wiley Eastern Ltd, 8th edition (1999).	
5.	Advanced Engineering Mathematics, 7e, by Peter V. O'Neil, Thomson Learning,6th edition (2007).	
6.	Advanced Engineering Mathematics, 2e, by M. D. Greenberg, Pearson Education, 2nd edition (2002).	

Bharati Vidyapeeth
(Deemed to be University)
College of Engineering, Pune

B. Tech. Sem. II Robotics & Automation
SUBJECT: - Electronic Devices & Circuits

Teaching Scheme	**Examination Scheme**	
Lecture: 3 Hours/week	**End semester exam:**	**60 Marks**
Practical: 2 Hours/week	**Internal Assessment:**	**40 Marks**
	Termwork:	**25 Marks**
	Total:	**125 Marks**
	Credits:	**Theory: 03**
		Practical: 01

Pre-requisites:

1. Basics of electricity and magnetism
2. Basic mathematics
3. Basics of semiconductor device physics

Course Objectives:

1. To teach the construction, working, ratings and application of passive devices like resistors, capacitors, inductors, transformers and relays
2. Introduce types of voltage and current sources and electrochemical cells
3. To teach the construction, working and ratings of devices like pn junction diode, bipolar junction transistor andMOSFET
4. To teach the basic application circuits like rectifiers, voltage amplifiers and drivers
5. To teach the construction, working and ratings of optoelectronic devices like LDR, LED, phototransistor and photovoltaic cell
6. To introduce the concept of grounding and shielding, to introduce the concept of PCB, types of PCB, PCB fabrication process, Basic PCB design rules, PCB assembly, introduce EDA tools used for PCB artwork design

Course outcomes:

After completing the course, the student will be able to:

1. Identify resistors, capacitors, inductors and transformer based on their construction, types and ratings and analyze simple circuits consisting of passive devices
2. Select power sources based on ratings and requirements
3. Identify active devices based on their types and ratings and plot their characteristic curves
4. Analyze basic circuits like rectifiers, BJT voltage amplifiers, switches and MOSFET switches
5. Use optoelectronic devices for various applications
6. Use the concepts of grounding and shielding, explain the PCB design and fabrication and assembly process and use EDA tools for designing single sided PCB for simple circuits

Unit 1: Passive Electronic Components **(04 Hours)**

- Introduction to the concept of active and passive electronic devices
- Types of resistors, construction, ratings and typical applications
- Types of capacitors, construction, ratings and typical applications
- Types of inductors, construction, ratings and typical applications

- Types of transformers, construction, ratings and typical applications
- Construction of relays, types and ratings
- Analysis of series and parallel resistors and capacitor circuits

Unit 2: Power Sources **(04 Hours)**

- Electrical power sources
- Types of voltage and current sources (AC and DC)
- Regulation
- Electrochemical cells and batteries
- Characteristics of various types of cells
- Applications

Unit 3: Active Electronic Devices **(08 Hours)**

- Classification of material based on band gap theory
- Types of semiconductors (p-type and n-type)
- pn junction diode and its characteristics
- Concept of DC and AC load line and ratings of pn junction diode
- Introduction to BJT (npn and pnp) and its construction and working mechanism
- BJT configurations and their input and output characteristics
- Types and ratings of BJT
- Construction and working of EMOSFET
- Characteristics of DMOSFET and EMOSFET
- Configurations and ratings of EMOSFET
- Introduction to OPAMP

Unit 4: Electronic Circuits **(08 Hours)**

- Basic diode circuits. Rectifiers
- Biasing circuits for BJT and MOSFET
- BJT and MOSFET as switches, relay and motor drivers
- Voltage and current amplifiers using BJT and MOSFET
- Basic OPAMP Circuits
- IC 555

Unit 5: Optoelectronic Devices **(06 Hours)**

- Construction and working of LDR and its characteristics, simple application
- Construction and working of LED and its characteristics and ratings
- Photo-transistor and its characteristics
- Introduction to the concept of electrical isolation and its importance
- Construction of opto-isolator(opto-coupler) and its ratings
- Construction and working of photovoltaic cell and its characteristics and ratings

Unit 6: Printed Circuit Boards **(06 Hours)**

- Concepts of grounding and shielding and its importance
- Building blocks of PCB (track, pads, fills) and design rules
- PCB fabrication and assembly
- Introduction to EDA tool for artwork design of a simple single sided PCB

List of Experiments:

1. Study of Lab Equipments (Power supply,Multimeter Function generator& DSO)
2. Study of Passive devices (Resistors,Capacitors,Inductors,Transformers & Relays)
3. To plot regulation characteristics of Power supply (Full wave rectifier output voltage Vs Load Current)
4. To plot characteristics of PN junction diode.
5. To plot input output characteristics of BJT (Common Emitter configuration)
6. To plot input output characteristics of BJT (Common Collector configuration)
7. To plot input output characteristics of BJT (Common Base configuration)
8. To plot Transfer characteristics & output characteristics of Inverting amplifier Non-inverting amplifier & Voltage follower
9. To plot Transfer characteristics & output characteristics of N-channel EMOS FET (To estimate GM & RD)
10. To plot LDR characteristics.
11. To plot characteristics of Optoisolator.
12. To plot characteristics of Photovoltaic cell.
13. Artwork design for single sided PCB using appropriate EDA tool design

Reference Books:

1. Passive Components for Circuit Design, Ian Sinclair,1st Edition 2000, ISBN: 9780750649339, Newnes
2. Grob's Basic Electronics, Mitchel Schultz,11th Edition,2010, ISBN-13: 978-0-07-351085-9,McGraw Hill
3. Fundamentals of Electronic Devices and Circuits, David A. Bell, 5th Edition,2008,ISBN:0195425235, 9780195425239,Oxford University Press,
4. Microelectronics Circuits, Adel S. Sedra& Kenneth C. Smith,7th Edition, 2015, ISBN 978–0–19–933913–6,Oxford University Press
5. Linden's Handbook of Batteries, Thomas Reddy,4th Editiion,2010, ISBN: 978-0-07-162419-0, McGraw Hill
6. Printed circuit boards: design, fabrication, assembly and testing,Raghbir Singh Khandpur,2006, ISBN 10:0071464204,McGraw Hill
7. The Circuit Designer's Companion, Peter Wilson, 4th Edition,2017, ISBN: 978-0-08-101764-7, Newnes

B. Tech (Robotics & Automation)
ENGINEERING CHEMISTRY

Designation of Course	**Engineering Chemistry**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 3 Hours/ Week	End Semester Examination	60 Marks	Theory: 03 Practical: 01
Practical : 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	
	Oral/Practical Examination	-- Marks	
	Total	125 Marks	4
Course Prerequisites:-	Student should have Basic Knowledge of Chemistry		
Course Objective	1. To understand technology involved in analysis and improving quality of water as commodity. 2. To acquire the knowledge of electro-analytical techniques that facilitates rapid and precise understanding of materials. 3. To understand structure, properties and applications of speciality polymers and nano material. 4. To study conventional and alternative fuels with respect to their properties and applications. 5. To study spectroscopic techniques for chemical analysis. **6.** To understand corrosion mechanisms and preventive methods for corrosion control.		
Course Outcomes:-	On completion of the course, learner will be able to– CO1: Select appropriate method of crystal analysis. CO2: Illustrate the knowledge of polymers, fabrication methods, conducting polymers in industrial fields. CO3: Illustrate the knowledge of engineering materials for various engineering applications. CO4: Analyze fuel with calorific value and apply combustion methods for use of alternative fuels. CO5: Explain corrosion and methods for prevention of corrosion. CO6: Apply the different methodologies for analysis of water and suggest suitable methods of treatment.		

Course Contents

Unit 1	**Material Chemistry**	**(8Hrs.)**

Crystallography: Unit cell, Law of crystallography, Weiss indices and Miller indices, Crystal defects(point and line defects), X-ray diffraction- Bragg's Law and numerical, Indexing of planes and directions,Imperfections in crystals, Density calculations, Volume density, Linear density, Atomic packing factor single crystal structure.

Unit 2	**Study of Polymers, Composite and ceramics Materials**	**(8Hrs.)**

A) Polymers: Introduction, plastics, thermo softening and thermosetting plastics, industrially important plastics like phenol formaldehyde, urea formaldehyde and epoxy resins, Conducting polymers and Biopolymers (Introduction, examples and applications.)

B)Composite: Introduction, Classification, constituents of composites, Fiber reinforced composites, unidirectional fiber reinforced composites, short fiber reinforced composites, particle reinforced composites, important types and failures of fiber reinforced composites, Advantages and applications of composites.

C) Ceramics: Introduction,classification, properties, ceramics crystal, Mechanical behaviour of Ceramics.

Unit 3	**Study of Non Ferrous Materials**	**(8Hrs.)**

Introduction, Copper and it's alloy, Alpha and alpha beta brasses, Zinc Equivalent, Copper Nickel alloy, Bronzes, Aluminium and it's alloy, Dispersion strengthening, Nickel and it's alloy, Metals at High and Low Temperature, Bearing Materials etc

Unit 4	**Fuels and Combustion**	**(8Hrs.)**

Definition, classification, characteristics of a good fuel, units of heat (no conversions).
Calorific value- Definition, Gross or Higher calorific value & Net or lower calorific value, Dulong's formula & numerical for calculations of Gross and Netcalorific values.
Solid fuels- Analysis of coal- Proximate and Ultimate Analysis- numerical problems and significance.
Liquid fuels- Petrol- Knocking, Octane number, Cetane number, Antiknocking agents, unleaded petrol, oxygenates (MTBE), catalytic converter.
Combustion- Calculations for requirement of only oxygen and air (by weight and by volume only) for given solid & gaseous fuels.

Unit 5	**Corrosion and Prevention**	**(8Hrs.)**

Introduction, Types of corrosion, Oxide film growth laws, Action of hydrogen, Polarization, Stress corrosion, Season Cracking, Prevention of corrosion, Design of component, Modification of environment, Cathodic Protection, Deposition and coating, Ion Implantation, PVD, CVD, Powder coating etc.

Unit 6	**Water Technology and Green Chemistry**	**(8Hrs.)**

Water Technology -Impurities in water. Hardness of water and its determination by EDTA method, Alkalinity of water and its determination. Numerical. Ill effects of hard water in boiler. Boiler feed water treatment 1)Internal treatment -calgon, colloidal and phosphate conditioning, 2)External treatment A) Zeolite process and its

numerical (B) Ion exchanger method. Desalination of brackish water/purification of water by reverse osmosis and electrodialysis.

Green Chemistry: Definition, goals of green chemistry, efficiency parameters, need of green chemistry.

Text Books/ Reference Books

1. Jain P.C & Jain Monica, Engineering Chemistry, Dhanpat Rai & Sons, Delhi, 1992.
2. Bhal & Tuli, Text book of Physical Chemistry (1995), S. Chand & Company, New Delhi.
3. O. G. Palanna , Engineering Chemistry, Tata McGraw-Hill Publication, New Delhi.
4. S. S. Dara, A textbook of Engineering Chemistry, McGraw-Hill Publication, New Delhi.

Reference books:

1. Barrow G.M., Physical Chemistry, McGraw-Hill Publication, New Delhi.
2. Shikha Agarwal, Engineering Chemistry- Fundamentals and applications, Cambridge Publishers - 2015.
3. WILEY, Engineering Chemistry, Wiley India, New Delhi 2014.
4. Atkins, Physical chemistry.

Assignments:

One assignment on each unit.

List of Experiments: (Perform any 08 Experiments)

1.To determine hardness of water by EDTA method
2. To determine strength of strong acid using pH meter
3. Titration of a mixture of weak acid and strong base using conductometer
4. Preparation of polystyrene/phenol-formaldehyde/urea-formaldehyde resin
5. To determine molecular weight/radius of macromolecule polystyrene/ polyvinyl alcohol by viscosity measurement.
6. Preparation of biodiesel from oil.
7. Determination of Saponification value of an oil sample.
8. Estimation of percentage of Iron in Plain Carbon Steel by Volumetric Method
9. To determine Surface Tension of given liquid by Stalagmometer
10. Study of corrosion of metals in medium of different pH.
11. To set up Daniel cell
12. To determine pH of soil
13. To determine Acidity of soil
14. Study of Bomb calorimeter for determination of calorific value.
15. Determination of calorific value of gas fuel by using Boy's gas calorimeter.
16.Determination of percentage of Ca in given cement sample

Electrical & Electronic Measurement techniques		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 04	End Semester Examination: 60 Marks	Credits : 04
Practical: 02	Continuous Assessment: 40 Marks	
	TW: 25 Marks	Credit: 01

Course Pre-requisites:	
The Students should have knowledge of	
1.	Basic electrical Engineering Parameters such as Voltage, current, Power, Energy, etc.

Course Objectives:	
	This course introduces knowledge about electrical and electronic measurements. The course is designed to learn different methods of measurements of various electrical parameters and also to learn the different physical parameters with the help of the various measurement techniques.

Course Outcomes: After learning this course students will be able to	
1	Describe the importance of measurement and identify various conventional meters.
2	Describe the digital measurement techniques.
3	Describe the construction, working principle of wattmeter and Energy meter and apply the knowledge to measure the power and energy.
4	Draw block diagram, state specifications, functions of various digital/automated meters, harmonic analyzer.
5	Observe the waveforms and measure the voltage, current, phase and frequency on CRO and to use DSO.
6	Measure the resistance, inductance and capacitance using various methods.

UNIT – I	**Fundamentals of measurements :**	**(08 Hours)**
	Introduction: Review of fundamental and derived units. SI units, significance of measurement, classification of instruments, mechanical, electrical, electronic instruments, Methods of Measurement, Direct Measurement, Indirect Measurement, ... Classification of Instruments Absolute and Secondary Instruments Analog Ammeters and Voltmeters : Classification of Instruments , Absolute **Instrume Electrostatic Instruments, Ohmmeters.**	
UNIT - II	**Digital Voltmeters and Ammeters**	**(08 Hours)**
	Introduction, Types of tools used in digital systems: crystal oscillator, counters, converters, voltage to frequency conversion and phase lock loop PLL. Digital Instruments: DC digital voltmeter – Schematic diagram, Auto ranging circuit, Polarity detection. Auto zeroing. AC digital voltmeter – Schematic diagram, Sample and hold, Recorder and display. DVM for very low amplitude signal. Measurement of current and resistance by digital millimeter. Complete circuit of Digital Multimeter (DMM).	
UNIT -	**Measurement of Power and Energy**	**(08 Hours)**
	Measurement of Power: Construction, working principle, torque equation, advantages/disadvantages, errors and their compensation of dynamometer type wattmeter, low power factor wattmeter, Active & reactive power measurement in three phase balanced & unbalanced system **Measurement of energy:** Energy Meters in AC circuits, Single Phase Induction Type Energy Meter - Construction, principle of operation, torque equation of induction type energy meter, errors and adjustments. Three phase three wires, and three phase four wire energy meter, Electronic energy meter	

UNIT -	**Electronic Devices and Signal Analyzer's**	**(08 Hours)**
	Electronic Voltmeters and their Advantages, Vacuum Tube Voltmeters, difference Amplifier Type Voltmeters, DC Voltmeters with direct Coupled Amplifier, Measurement of Power at Audio and Radio Frequencies. Concept of: Numeric meter & its types Measurement of power & energy by sampling technique automatic meter reading (AMR) and advanced metering infrastructure (AMI), Wave Analyzers and its applications. D.C. Potentiometer , Crompton's Potentiometer, Standard Cell Dial , True Zero Brooks Deflection Potentiometer, Voltage Ratio Box , A.C. Potentiometers Requirements of AC Potentiometer, Drysdale-Tinsley Polar type A.C. Potentiometer, Advantages and Disadvantages of AC Potentiometer, Application of AC Potentiometer.	
UNIT - V	**Cathode Ray Oscilloscope (CRO)**	**(08 Hours)**
	Introduction, Cathode Ray Tube (CRT), Electron Gun, Electrostatic focusing, deflection, effect of beam transit time and frequency limitations, defection plates, screen for CRT's, color CRT displays, time base generators, Oscilloscope amplifiers, Vertical input and sweep generator signal synchronization, attenuators, basic CRO circuits, observation of waveforms on CRO, measurements of voltage and current, measurement of phase and frequency, multi input oscilloscopes, sampling oscilloscopes. Comparison between digital and analog storage oscilloscopes, accessories of CRO. Digital Storage Oscilloscope – Principle of operation and waveform reconstruction.	
UNIT - VI	**Measurement of Electrical Parameters**	**(08 Hours)**
	Measurement of Resistance – Classification of resistances, Measurement of medium resistance – Ammeter-voltmeter method, Wheatstone bridge. Measurement of Low resistance – Kelvin Double bridge. Measurement of high resistance – difficulties, use of guard circuit, Methods: direct deflection, loss of charge, Megger. Measurement of earth resistance – Fall of potential method, earth tester. Localization of cable faults. **Measurement of Inductance and Capacitance** **AC Bridges:** Introduction, sources and detectors for ac bridge, general equation for bridge balance. General form of ac bridge. Measurement of Inductance: Maxwell's Inductance, Anderson's Bridge.. Measurement of Capacitance- Schering Bridge, High voltage Schering bridge.	

Term Work:

The term work shall consist of record of minimum eight experiments.

1. Measurement of Voltage, current and resistance using digital voltmeter and digital multimeter.
2. To measure power in three phases balanced load by one wattmeter method.
3. To measure power in three phase balanced/ unbalanced load by two wattmeter method.
4. To measure reactive power in three phase circuit by one wattmeter method.
5. To calibrate single phase energy meter at (i) unity power factor (ii) 0.5 lagging power factor (iii) 0.5 leading power factor (analog / Digital)
6. To study and analyze the various electrical parameters using Power Analyzer.
7. To study the observation of waveforms on CRO, measurements of voltage and current, measurement of phase and frequency using CRO.
8. Study of digital storage oscilloscope.
9. Measurement of resistance by Kelvin double bridge/ Wheatstone bridge/Ammeter-voltmeter method
10. To study Megger/Earth Tester
11. Measurement of capacitance and loss angle by Schering Bridge.
12. Measurement of inductance by Anderson's bridge/ Maxwell's Inductance Bridge.
13. Measurement of resistance, capacitance and inductance using LCR meter.

Text Books:

1. A Course in Electrical and Electronic measurements & Instrumentation – by A. K. Sawhney, Dhanpat Rai & Sons.
2. Electronic Instrumentation: H.S. Kalsi – THM, 2nd Edition 2004.
3. A Course in Electronic and Electronic measurements by J. B. Gupta, S. K. Kataria & Sons.

Reference Books:

1. Electrical Measurement & Measuring Instruments Fifth edition, by E. W. Golding & Widdies, A. H. Wheeler & Co. Ltd.
2. Electronic measurement and instrumentation by Dr. Rajendra Prasad, Khanna Publisher, New Delhi.
3. Introduction to Measurements and Instrumentation, Second Edition by Ghosh, PHI Publication.
4. Introduction to Measurements and Instrumentation by Anand .PHI Publication

FUNDAMENTALS OF DESIGN & MANUFACTURING ENGINEERING

Designation of Course	**Fundamentals of Design & Production Engineering**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	Theory: 03
Practical:- 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	1.0
	~~Oral/Practical~~	--	--
	Total	125 Marks	--
Course Prerequisites:-	Students should have the basic knowledge of Physics at Higher Secondary School Certificate		
Course Objective	To develop understanding about thermal, fluid, design and manufacturing aspects in mechanical engineering		
Course Outcomes:-	1. Design and analyze mechanisms of machines 2. Analyze mechanical elements and compare their suitability for various applications 3. Illustrate metal working processes with sketches 4. Classify metals cutting machines and illustrate various operations		

Course Contents

Unit 1	**Mechanisms of Machines**	(06 Hrs.)
Kinematic link, Kinematic pair, Kinematic chain, mechanism of machines, structure, Degree of freedom of planar mechanism, Inversions of four bar chain, Inversions of Single and double slider crank chain, Geneva mechanism, Ratchet and Paul mechanism		
Unit 2	**Introduction to Machine Elements**	(06 Hrs.)
Types of Belts and belt drives, Chain drive, rope drive, Types of gears, Types of gear trains, Types of Couplings, types of friction clutch, Power transmission shafts, axles, keys, types of Keys, Sliding Contact and Rolling Contact Bearing, Bush and ball bearings, Types of brakes.		
Unit 3	**Introduction to Robotics**	(06 Hrs.)
History of robotics, Definition of Robotics and robot, Laws of robotics, Classification of robots, Application of robots. Robot anatomy terms such as Axis/axes, End effector, Degree of freedom, Degree of mobility, Kinematics, Joints, Work envelope, Pay load, Reach, speed, Acceleration, Accuracy, Precision, Repeatability, Mounting, Footprint, Cycle time. Components of robots such as Sensors, Power conversion unit, Actuators, Manipulators, Controllers, Base and User Interface. Future of robotics.		
Unit 4	**Introduction to Metal Forming Processes**	(06 Hrs.)

Introduction, Hot working, Cold working, Sheet metal forming, Sheet metal cutting, Forging, Open die forging, Closed die forging, Forging defects, Rolling, Ring Rolling, Cold Rolling, Rolling defects, Extrusion, Extrusion process, wire drawing, extrusion defects, deep drawing

Unit 5	**Introduction to Casting Processes**	(06 Hrs.)

Sand casting, Types of pattern, materials, pattern making allowances, Moulding sand- properties and testing, Hand and machine moulding, core making, melting and pouring. Introduction to Melting furnaces, Defects in casting. Die casting, low pressure permanent mould castings, hot and cold chamber processes, Centrifugal casting, Semi-centrifugal casting, Investment casting.

Unit 6	**Introduction to Welding Processes**	(06 Hrs.)

Classifications of welding process, Arc welding – theory SMAW, GTAW, GMAW, FCAW, Submerged arc welding stud welding. Resistance welding- Theory, spot, seam, projection welding processes. Gas welding. Friction welding, ultrasonic welding, thermit welding, electron beam and laser welding. Use of adhesives for joining process.

Term work shall consist of any Eight Experiments of the following list

1. Assembly and working of 4-bar, 6-bar, 8- bar planner mechanisms
2. Finding relation between input angle and output angle for various link lengths
3. Study of power transmitting elements coupling, gears and bearings
4. Study and demonstration of different types of clutches
5. Study and demonstration of operations on Centre lathe
6. Study and demonstration of operations on drilling machines
7. Demonstration of various metal forming processes
8. Demonstration of moulding processes
9. Demonstration of casting processes
10. Demonstration of welding techniques

Text Books/ Reference Books

1. Mechanisms and Machine Theory, Ambekar A.G., Prentice-Hall of India, Eastern Economy Edition (2007)
2. Theory of Machines, S.S. Ratan, Tata McGraw Hill, 4th Edition (2014).
3. Introduction to Robotics. S. K. Saha. McGraw Hill, 2nd Edition
4. A Textbook of Production engineering. P.C. Sharma, S. Chand Publication, New Delhi, 2nd edition, 8th Edition (2014).
5. A Textbook of Manufacturing Technology: Manufacturing Processes, R. K. Rajput, Laxmi Publications (P) Ltd, 2nd Edition 2015

Assignments: At least ONE assignment on each unit

Problem Solving with Simulation & Programming		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Practical: 04 Hours / Week	Term Work: 25 Marks Oral: 25marks	02 Credits
Course Prerequisites:		
The students should have knowledge of Basic mathematics, computer operation and basic electrical engineering		
Course Objectives		
The course introduces fundamental concepts of simulation and programming for problem solving to all first year engineering students.		
Course Outcomes		
1.	To Understand and apply knowledge of basic concepts of problem solving.	
2.	To Understand and apply knowledge of Simulation.	
3.	To Describe Simulation Languages and softwares	
4.	To Describe and apply fundamental concepts of MATLAB programming	
5.	To Describe and apply fundamental concepts of MATLAB Simulink.	
6.	MATLAB Basic electrical engineering applications	
7.	MATLAB Simulink applications in Power electronics	
8.	To make awareness of Industrial applications of simulation softwares and MATLAB for electrical engineers.	
Unit-I	**Problem Solving:**	(6 hours)
	What is problem solving (definition and meaning) and why is it important, defining the problem, understanding complexity of problem solving, problem-solving processes (basic steps of the problem-solving process), types of problems, problem solving methods, Problem solving and decision making (solving problems and making decisions), problem solving examples. **Introduction to computer Problem Solving:** Introduction, the problem solving aspect, top down design, implementation of algorithm, program verification, the efficiency of algorithms, the analysis of algorithms.	
Unit-II	**Introduction to Simulation:**	(6 hours)
	What is simulation: Modeling basics, computer simulation (Popularity and advantages, different kinds of simulation), How simulation gets done (by hand, programming in general languages, simulation languages, high level simulators, Uses of simulations (past , present, future). **Fundamentals of simulation:** Steps in simulation study, phases of simulation study, advantages of simulation, limitations of simulation techniques, areas of applications, Monte Carlo Method, Examples on Monte Carlo Method.	
Unit-III	**Simulation Languages and softwares:**	(6 hours)
	Simulation Languages: Introduction, merits of simulation languages, simulation languages and simulators, desirable features of simulation software, discrete event simulation tools, classification of simulation tools, SIMSCRIPT, simulation language for alternative modeling(SLAMII), Simulation analysis(SIMAN), General purpose simulation system(GPSS), Simulation examples **Software's:** Description of P-Spice, Types of analysis, Description of simulation software tools (like OrCAD / PROTEL / Proteus / Microcap) Schematic Description: Introduction,	

	Input files, element values, Nodes, circuit elements, sources, output variables, format of circuit and output files, drawing the schematic, Design rule Check (DRC), Netlist details.	
Unit-IV	**Introduction to MATLAB programming** (theory & MATLAB examples)**:**	(6 hours)
	Introduction, starting and ending a MATLAB session, Fundamentals of MATLAB programming (MATLAB variables, arrays, matrices, MATLAB operators- arithmetic, relational, logical, MATLAB graphics(plots, subplots, other types of plots), benchmarking and looping functions(branching functions, looping functions), miscellaneous functions(string function, input/output function), examples on above topics, advantages of MATLAB, disadvantages of MATLAB, various MATLAB commands & their explanation.	
Unit-V	**Introduction to MATLAB Simulink** (theory & MATLAB examples)**:**	(6 hours)
	Introduction, simulation steps, types of mathematical model, developing a model, getting simulink (creating a new model/opening an existing simulink model), creating and simulating a simulink model, simulink solution of differential equation, solvers, keystrokes or mouse actions for handling blocks and lines, assigning variables, observing variables during simulation, storing saving data, linking script file/M-file with model file, data import/export, creating and masking subsystems, solution using laplace approach, simulation of non-linear system, equivalent circuit.	
Unit-VI	**MATLAB Basic electrical engineering applications:** (theory & MATLAB examples on each applications)	(6 hours)
	Basic electrical engineering applications(introduction, elementary definitions, basic waveforms, average value -RMS value -peak value, ohms law, Kirchhoff's laws, independent and dependent Dc sources, series and parallel circuits, resonance phenomenon, network theorems, apparent power-active power-reactive power, three phase source and load simulation, transformers.	
Unit-VII	**MATLAB Simulink applications in Power electronics** (theory & MATLAB examples on each applications):	(6 hours)
	Introduction, simpower systems toolbox (exploring simpower systems libraries, simpower systems libraries), building and simulating a simple circuit(study of voltage and current relationship in a series RLC circuit, study of resonance in a series RLC circuit), interfacing the electrical circuit with simulink(electrical terminal ports and simulink ports), diode circuits and rectifiers (simulation of single phase half wave rectifier, simulation of single phase full wave rectifier, use of freewheeling diode)	
Unit-VIII	**Industrial applications**	(6 hours)
	General applications of simulink and MATLAB in various industries.	
Termwork:		
	The term work shall consist of record of minimum sixteen experiments. **List of experiments:** 1. Schematic drawing & component symbol creation 2. Hierarchical schematic drawing **Simulation Experiments** 3. Simulation and analysis (bias point analysis, time domain, AC sweep, DC sweep, parametric) of :RLC Circuit Simulation and analysis (bias point analysis, time domain, AC sweep, DC sweep, parametric) of : Transistorized Circuit Simulation and analysis (bias point analysis, time domain, AC sweep, DC sweep, parametric) of : Two Stage Amplifier Simulation and analysis (bias point analysis, time domain, AC sweep, DC sweep,	

	parametric) of : IC Based Circuits 4. Experiments based on noise analysis and Monte-Carlo analysis 5. To simulate simple calculator that performs basic tasks such as addition, subtraction, multiplication and division with special operations like computing xy and x!. 6. To accept the number and Compute a) square root of number, b) Square of number, c) Cube of number d) check for prime, d) factorial of number e) prime factors 7. To accept two numbers from user and compute smallest divisor and Greatest Common Divisor of these two numbers. 8. To accept a number from user and print digits of number in a reverse order. 9. To input binary number from user and convert it into decimal number. 10. 14. To calculate steady state error for different inputs and different types of system(MATLAB) **MATLAB Experiments** 11. Listing of some common MATLAB commands and executing these commands with examples 12. Experiment on Introduction to MATLAB programming: 13. Experiment on MATLAB Basic electrical engineering applications/ Solving network theorems using MATLAB 14. Experiment on MATLAB Simulink applications in Power electronics **Proteus Experiments** **15.** Design of a Regulated Power Supply **16.** Design of LED blinking system	
	Text books:	
	1. **How to solve it by computer** by RG Dromey(eastern economy editions) 2. **Simulation** with Arena by W.David Kelton, randall P. Sadowski, nancy B. Swets(Mc Graw Hill international edition). (unit 1 & 2) 3. **System Simulation** by D.S.Hira (S. Chand & Company Pvt Ltd.) 4. **MATLAB and SIMULINK** for engineers by Agam Kumar Tyagi (Oxford University Press). 5. **MATLAB and its Applications** in Engineering by Raj Kumar Bansal, Ashok Kumar Goel, Manoj Kumar Sharma (Pearson India Education Services Pvt Ltd.) 6. Introduction to **MATLAB programming** toolbox and sumulink by Jaydeep Chakravorthy (University Press India Private Limited) 7. M. H. Rashid 'Introduction to P-spice using OrCAD for circuits and Electronics' – Pearson Education	
	Reference Books:	
	1. User manuals of PROTEL, PROTEUS, OrCAD, Microcap 2. R. G. Dromey, "How to Solve it by Computer", Pearson Education India; 1st edition, ISBN10: 8131705625, ISBN-13: 978-8131705629 Maureen Spankle, "Problem Solving and Programming Concepts", Pearson; 9th edition, ISBN-10: 9780132492645, ISBN-13: 978- 0132492645	
	Assignments:	
	Assignments should be able to verify course outcome and skills of group work, communication skills. Two assignment on each unit (total 16 assignments)	

Soft Skills
(All branches) Sem-II

Designation of Course	**Soft Skills**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 2 Hours/ Week	End Semester Examination	50 Marks	Theory: 02 Tutorial: 00 Practical: 00
Tutorial : 00 Hours/ Week	Internal Assessment	00 Marks	
	Term Work	- Marks	
	Oral/Practical Examination	-- Marks	
	Total	50 Marks	2
Course Prerequisites:-	Students should have knowledge of basic soft skills Students should have basic information of self analysis techniques Basics of business manners		
Course Objective	The course objective of Soft skills puts the following class teaching objectives, considering soft skills as a wheel rolling aspects in today's world, the focus is on honing the skills self awareness and self development. It also puts emphasis on developing the interpersonal skills. Honing the skills of time management and stress management among students through appropriate activities, this will help them in their business ventures. It also aims to develop the skills of conflict resolution, problem solving and inclusion ability at work place.		
Course Outcomes:-	Graduates will able to **01.** To understand the concept of soft skills and its implication at workplace **02.** To analyze SWOT and TOWS techniques and its implementation in career development **03.** To develop team building and leadership skills by applying motivational factors **04.** To build up the time management mastery through Pareto Principles and time matrix **05.** To inculcate appropriate business ethics and etiquettes for effective professionalism **06.** To apply the negotiation, conflict resolution and problem solving skills at workplace		

Course Contents

Unit 1	Introduction	**(4 Hrs.)**
ft skills, meaning, need and importance, difference between soft skills and hard skills, life skills and personal skills, applying soft skills across culture		
Unit 2	Self awareness and self development:	**(4Hrs.)**
Self assessment, self appraisal through SWOT and TOWS, developing perception and attitude, personal goal setting and self management, Career planning and personal success factors		
Unit 3	Developing interpersonal skills:	**(4Hrs.)**
uational conversation, building team, team dynamics, developing leadership skills, difference between leader and manager, role and responsibilities of leader, different styles of leadership, Maslow's theory of motivation		
Unit 4	Time management:	**(4Hrs.)**
Time management matrix, apply Pareto principle (80/20) to the time management, handle the most common time		

wasters, maximizing personal effectiveness		
Unit 5	Business ethics and corporate etiquettes:	**(4Hrs.)**
hics- its definition, importance and code of ethics, workplace etiquettes and professionalism, communication etiquettes, telephonic etiquettes, meeting etiquettes		
Unit 6	oblem solving, Diversity and inclusion:	**(4Hrs.)**
nflict resolution, negotiation and problem solving, handling different problems at workplace, Diversity and inclusion at workplace, LGBTQ+, its advantages and disadvantages		

Reference Books:

01. Soft Skills by Meenkashi Raman, published by Cengage publishers
02. Soft skills for Managers by Dr. T. Kalyana Chakravarthi and Dr. T. Latha Chakravarthi published by biztantra
03. Personality development and Soft Skills by Barun K. Mitra by Oxford University press
04. Soft Skills by Dr. K Alex published by Oxford University press
05. The Ace of Soft Skills: Attitude, Communication and Etiquettes for Success by Ramesh Gopalswamy, published by pearson education
06. Seven Habits of Highly effective People: Powerful lessons in personal life by Stephen Covey

Recommended web-links for enhancing English language and business communication

01 http://www.englishlearner.com/tests/test.html
02. http://www.youtube.com/playlist?list=PLY3DFj1jjj0URoyHOnxuau610EgzOtoHI

Assignments:
At least ONE assignment on each unit

Production Practice

TEACHING SCHEME: EXAMINATION SCHEME: CREDITS ALLOTTED:

Practical: --2 Hrs/Week TW : 25 Marks 01 Credits

Pre-requisites: Basics of Manufacturing processes ,work shop tools , equipment's used in workshops.

Course Outcomes:

· Understand modern manufacturing operations, including their capabilities, limitations.

· Learn how to analyze products and be able to improve their manufacturability and make the cost effectively

· To acquire practical skills in the trades.

· To provides the knowledge of job materials in various shops.

Course Objectives

Student Should be able to,

1) Get the idea about Plastic Formation and sheet metal work

2) Understand the various machining operations on lathe

3) Understand the processes of casting.

4) Understand the techniques of TIG, MIG and spot Welding.

Four Sections

Section 1 – Plastic Moulding And Pattern Making job (Three Practical's For Individual Job Making)

Study of tools & operations like plastic moiding , Pattern making, Mould making with the use of a core.

Section 2 – Machining Processes (4 Practicals For Individual Job Making On Lathe Machine)

Study of tools & operations, Simple exercises involving turning on lathe work, Make perfect male-female joint, Simple exercises involving drilling/tapping/threading.

Section 3 –Casting And Sand Molding.(Two Practical's Casting Formation as a Batch Job)

Study of tools & operations like Pattern making, Mould making with the use of a core. Various Casting processes, Sand casting, Die casting.

Section 4 – Arc,TIG, MIG And Resistance Welding Processes (Three Practical's For Individual Job Making)

Study of tools & operations of Arc welding, Simple butt and Lap welded joints, Oxy-acetylene flame cutting, TIG, MIG And Resistance Welding Processes.

Designation of Course	Hydraulics & Pneumatics: Principals		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical:- 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work & Oral	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites:-	1. Engineering Mathematics. 2. Engineering Physics. 3. Engineering Mechanics.
Course Objectives:-	To provide knowledge about 1. Properties of fluids, concepts of fluid statics, kinematics & dynamics. 2. Concepts of fluid power and pumps and its control. 3. Hydraulics and Pneumatics – Actuators and Circuits.
Course Outcomes:-	On completion of the course, students will be able to 1. **Understand** properties of fluids and **analyze** concepts of fluid statics. 2. **Understand** concepts related to fluid kinematics and **analyze** practical problems. 3. **Understand** concepts related to fluid dynamics, flow through pipes and **analyze** practical problems. 4. **Understand** concepts related to fluid power system, Power units and accessories and **analyze** pump performances. 5. **Understand** concepts related to Control of fluid power and Control valves. 6. **Understand** concepts related to Hydraulics and Pneumatics – Actuators and Circuits and its application.

Course Contents

Unit 1	**Properties of Fluids & Fluid Statics**	**(8 Hrs.)**

Properties of Fluid:-Definition of fluid, concept of continuum, Density, Specific Weight, Specific Gravity, Dynamic Viscosity, Kinematic Viscosity, Newton's law of viscosity, types of fluid, Rheological diagram, Surface Tension, Capillarity, Compressibility, Vapour pressure, Classification of fluid.

Fluid Statics: Hydrostatic law, Pascal's Law, Pressure at a point, Total Pressure, Archimedes Principle, Buoyancy and stability of floating and submerged bodies, Metacentric height.

Unit 2	**Fluid Kinematics**	**(8 Hrs.)**

Description of fluid motion- Eulerian and Langragian approach, Types of flow (steady, unsteady, uniform, non-uniform, laminar, turbulent, One, Two and Three dimensional, compressible, incompressible, rotational, Irrotational), Continuity equation in Cartesian co-ordinates, flow net, Control volume, Material derivative and acceleration.

Unit 3	**Fluid Dynamics and Losses in Pipes**	**(8 Hrs.)**

Linear momentum Equation using differential Approach, Introduction to Navier-Stoke's Equation, Euler equation of motion, Derivation of Bernoulli's equation along a stream line, application of Bernoulli's equation to Pitot tube.

Losses in Pipes: Energy losses through pipe-Major and Minor losses, Pipes in series and parallel, Darcy-Weisbach equation

Unit 4	**Basics of Fluid Power and Pumps**	**(8 Hrs.)**

Components of fluid power system, advantages and limitations. Difference between electrical, pneumatic and fluid power systems. Seals, sealing materials. Types of pipes, hoses, material. Fluid conditioning through filters, strainers, sources of contamination and contamination control.

Power units and accessories: Types of power units, reservoir assembly, sizing of reservoirs, constructional details, pressure switches, temperature switches. Accumulators: Types, selection procedure, applications of accumulators. ISO symbols for hydraulic and pneumatic Components

Pumps: Types, classification, principle of working and constructional details of vane pumps, gear pumps, radial and axial plunger pumps, screw pumps, power and efficiency calculations, and characteristics curves

Unit 5	**Fluid Power Control**	**(8 Hrs.)**

Necessity of fluid control through pressure control, directional control and flow control valves.

Control valves:

i) Principle of pressure control valves, direct operated and pilot operated pressure relief valves, pressure reducing valve, sequence valve.

ii) Principle of flow control valves, pressure compensated and non-compensated flow control valves.

iii) Principle of directional control valves, types of directional control valves, two-way, three-way, four-way valves, check valve and shuttle valve. Open centre, close centre, tandem centre valves. Actuating devices- manually operated, mechanically operated, solenoid operated, pilot operated, lever operated.

Unit 6	**Hydraulic & Pneumatic Circuits**	**(8 Hrs.)**

Linear and rotary actuators: Types, construction and characteristics. Cylinder mountings, cushioning of cylinders.

Hydraulic & Pneumatic circuits: Simple reciprocating, regenerative, speed control (meter in, meter out and bleed off), sequencing, synchronization, traverse and feed, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, unloading circuit, motor breaking circuit etc.

Compressors: Types, principle of working and constructional details. Comparison of pneumatic with hydraulic power transmissions. Types of filters, pressure regulators, lubricators, mufflers, dryers, direction control valves, pneumatic actuators, shuttle valve, two pressure valve, quick exhaust valve and time delay valves. Speed regulating methods, pneumatic circuits, reciprocating, cascading time delay etc. Application of pneumatics in low-cost automation and in industrial automation

Term Work: (Any 8 experiments needs perform during practical's)

1. Study of Pressure Measuring Devices.
2. Measurement of Viscosity using Redwood Viscometer
3. Stability of Floating Bodies and Optimum Loading Capacity.
4. Verification of Modified Bernoullis Equation.
5. Calibration of Venturimeter.
6. Calibration of Orificemeter.
7. Laminar and Turbulent Flow by Reynold's Apparatus.
8. Discharge over Notches.
9. Study of Minor Losses due to Pipe Fitting.
10. Study of flow control valves (Meter in, Meter out Circuits).
11. Study of ISO/JIC Symbols for hydraulic and pneumatic systems.
12. Following experiments to be done on hydraulic trainer
    a) Regenerative circuit b) Speed control circuit
    c) Sequencing circuit d) Traverse and feed circuit etc.
13. Following experiments to be done on pneumatic trainer
    a) Automatic reciprocating circuit
    b) Speed control circuit
    c) Pneumatic circuit involving Shuttle valve/ Quick exhaust valve / Two pressure valve
14. Design of simple hydraulic/pneumatic systems used in practice such as hydraulic clamp, jacks, dumper, forklift etc by using fluid simulation software's such as LVSIM®-HYD & PNEU, AUTOMATION STUDIO.
15. Study of accumulators/actuators/intensifiers/hydraulic and pneumatic power brakes.
16. Industrial visit to study Hydraulic / Pneumatic based Automation systems

Assignment:

Assignment Based on each unit.

Text Books:

1. Dr. P.N. Modi and Dr. S.M. Seth, "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House.
2. Dr. R.K. Bansal, "Fluid Mechanics and Hydraulic Machines – l", Laxmi Publication Pvt. Ltd., New Delhi.
3. Streeter V. L. and Wylie E. B. Fluid Mechanics McGraw Hill International Book Co.
4. Garde R. J. and Mirajgaonkar, Engineering Fluid Mechanics, Nem Chand & Bros, Roorkee, SCITECH, Publication (India) Pvt. Ltd.
5. Cengel & Cimbla Fluid Mechanics, TATA McGraw-Hill. 8. Irving Shames, "Mechanics of Fluid", McGraw Hill Publication
6. Esposito A, Fluid Power with application, Prentice Hall
7. Majumdar S.R, Oil Hydraulic system- Principle and maintenance ,Tata McGraw Hill
8. Majumdar S.R, Pneumatics Systems Principles and Maintenance ,Tata McGraw Hill
9. Stewart H. L, Hydraulics and Pneumatics , Taraporewala Publication

Reference Book:

1. Pipenger J.J, Industrial Hydraulics, McGraw Hill
2. Pinches, Industrial Fluid Power, Prentice Hall
3. Yeaple, Fluid Power Design Handbook
4. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science and Technology Books
5. ISO - 1219, Fluid Systems and components, Graphic Symbols
6. Standard Manufacturer's Catalogues

Project Based Learning

Topics for the project based learning will be given by respective faculty member.

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	**Theory of Machines**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours/Week	Internal Assessment	40 Marks	
	Term Work & Oral	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites:-	1. Engineering Physics and Mathematics 2. Engineering Mechanics
Course Objectives:-	1. To develop competency in understanding of theory of different types of gear. 2. To make the students conversant with kinematic analysis of mechanisms applied to real life and industrial applications. 3. To develop the competency to analyse the velocity and acceleration in mechanisms using analytical and graphical approach. 4. To develop understanding of static and dynamic balancing and gyroscopic effect.
Course Outcomes:-	On completion of the course, students will be able to 1. **Understand** the fundamental concept of Lower pair mechanisms and **apply** to real life and industrial applications. 2. **Understand** the basic concept of kinematic analysis and **evaluate** forces acting on reciprocating engine by graphical and analytical method. 3. **Understand** the concept of velocity and acceleration of any planar mechanism and **analyze** it graphically by using relative velocity - acceleration method and ICR method, Coriolis component of acceleration. 4. **Understand** the gear theory which will be the prerequisite for gear design. 5. **Apply** the principles of balancing of masses to various links, mechanisms and engines 6. **Apply** the principles of gyroscopic effects and stabilization on various transport vehicles.

Course Contents

Unit-I	**Mechanisms with Lower Pair**	**(08 Hrs.)**

Introduction, Pantograph, Straight line mechanisms- Exact and Approximate, Hook Joint, Double Hook's Joint, Steering gear mechanisms: Condition for correct steering, Davis steering gear mechanism, Ackermann steering gear mechanism.

Theory and analysis of Compound Pendulum, Concept of equivalent length of simple pendulum, Bifilar suspension, Trifiler suspension.

Unit-II	**Inertial Forces in Reciprocating Parts**	**(08 Hrs.)**

Analytical method for displacement, velocity and acceleration analysis of slider cranks Mechanism. Klein's construction.

Dynamics of Reciprocating Engines: Two mass statically and dynamically equivalent system, Correction couple, static and dynamic force analysis of reciprocating engine mechanism, Torque Exerted on crankshaft.

Unit-III	**Kinematic Analysis of Mechanisms: Graphical Methods**	**(08 Hrs.)**

Relative Velocity Method: Relative velocity of a point on a link, Angular velocity of a link, Sliding velocity, Velocity polygons for simple mechanisms.

Relative Acceleration Method: Relative acceleration of a point on a link, Angular acceleration of a link, Acceleration polygons for simple mechanisms.

Coriolis component of acceleration.

Instantaneous Centre of Rotation(ICR) Method (limit to only 6 link mechanisms)- Kennedy's Theorem, Body and space centrode.

Unit-IV	Gears	(08 Hrs.)
Classification, Spur gear: definition, terminology, fundamental law of toothed gearing, involute and cycloidal profile, path of contact, arc of contact, conjugate action, contact ratio, minimum number of teeth, interference and under cutting, Friction in gears. **Helical gears**: nomenclature, Center Distance. Worm & Worm wheel, Bevel gears, Spiral gears, Introduction to Gear Box, Electronic Gearing.		
Unit-V	**Balancing**	**(08 Hrs)**
Static and dynamic balancing, balancing of rotating masses in single and several planes, primary and secondary balancing of reciprocating masses, balancing in single cylinder engines, balancing in multi-cylinder in-line engines, direct and reverse cranks method -radial and V-engines.		
Unit-VI	**Gyroscope**	**(08 Hrs.)**
Gyroscopes- Gyroscopic forces and Couples, Gyroscopic stabilisation for ship and Aeroplane, Stability of four-wheel drive vehicle moving on curved path, Stability of a two-wheel vehicle.		

Term Work

Term work shall consist of following experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. Compound Pendulum
2. Bifilar Suspension Method
3. Trifilar Suspension Method
4. Velocity and acceleration analysis using Graphical methods by Klein's construction
5. Velocity analysis using Graphical methods by ICR.
6. Velocity and acceleration analysis using Graphical methods by Polygon method.
7. Velocity and acceleration analysis using Graphical methods i.e., polygons involving Coriolis component.
8. To determine Corioli's Component of Acceleration at various speeds of rotation and water flow rates.
9. To draw conjugate profile for any general type of gear tooth
10. To generate involute gear tooth profile and to study the effect of undercutting and rack shift using model.
11. To balance a system of masses revolving in a plane on a rotating shaft on V Lab
12. To verify the gyroscopic principles.

Assignments

Numerical and/or theory questions on each unit from previous year question papers of GATE/ESE Mechanical Engg. examinations.

Tutorial

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Lower Pair Mechanism
2. Static and dynamic force analysis
3. Velocity and Acceleration analysis using graphical method.
4. Spur Gears
5. Balancing
6. Gyroscope

Reference Books

1. Thomas Bevan, "Theory of Machines", CBS Publishers & Distributors, Delhi.

2. Shigley J.E. and Uicker J.J., “Theory of Machines and Mechanisms”, McGraw Hill, Inc.
3. Ghosh Amitabh and Malik A.K., “Theory of Machines and Mechanisms”, East-west Press.
4. Hall A.S., “Kinematics and Linkages Design”, Prentice-Hall.
5. Hartenberg and Denavit, “Kinematic Analysis and Synthesis of Mechanisms”.
6. Erdman, A. G. & Sandor, G.N., “Mechanism design, Analysis and synthesis”, Vol 1, Prentice –Hall of India.

Text Books

1. Rattan S. S., “Theory of Machines”, Tata McGraw Hill.
2. Ballaney P. L., “Theory of Machines”, Khanna Publishers, Delhi.
3. R. S. khurmi, “Theory of Machines’, S Chand Publication.

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. Demonstration model of Pantograph mechanism
2. Demonstration model of Automobiles steering gear mechanism in real life
3. Demonstration model of Ackerman and Davis steering gear mechanism and its comparison.
4. Demonstration models of exact straight line motion mechanism.
5. Demonstration o relative velocity and acceleration method and Klien’s construction in slider crank mechanism
6. Demonstration model Kennedy’s Theorom (Three centre in line)
7. Demonstration model to understand Coriolli’s Effect
8. Demonstration model of different types of gears
9. Chart to understand various terminology of spur gear
10. Demonstration model for failure modes of gear tooth.
11. Chart to understand different methods to avoid interference in spur gear.
12. Demonstration model of static and dynamic balancing.
13. Demonstration model of balancing of rotating masses.
14. Demonstration model of balancing of reciprocating masses.
15. Demonstration model of balancing V-Engine.
16. Demonstration model to understand gyroscopic effect in Ship, aeroplane and automobile.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	**Strength of Machine Components**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/Week	Assignments Internal	40 Marks	
Tutorial: - 01 Hours/ Week	Tutorial		01
	Term Work	25 Marks	01
	Total	**125 Marks**	**05**

Course Prerequisites:-	1. Engineering Mathematics 2. Engineering Mechanics 3. Engineering Science
Course Objectives:-	1. Understand simple and principal stress and strain 2. Able to find principal stresses on any oblique plane by analytical and graphical method. 3. Able to draw shear force and bending moment diagram and find slope and deflection of beam 4. Able to draw bending stress and shear stress diagram at different cross section in I, C and T section beam. 5. Able to find stresses in shaft in torsional, combined torsional and bending, combined torsional and axial loading. 6. Able to solve problems on strain energy and Euler's column.
Course Outcomes:-	On completion of the course, students will be able to 1. **Understand** the concept of simple stress and strain and apply to find it for simple component. 2. **Understand** the concept of principal stress analytical and graphical by Mohr's circle; and apply it to find stresses on any oblique plane inclined to principal plane. 3. **Understand** the concept of shear force and bending moment and apply it to find shear force diagram and bending moment diagram for any loading condition on simply supported beam and cantilever beam. 4. **Understand** the concept of slope and deflection and apply it to find for any loading condition on simply supported beam and cantilever beam by maculays double integration method 5. **Understand** the concept of pure bending and shear and apply it to find bending stress and shear stress diagram of I, C and T section of beam. 6. **Understand** the concept of column theory and strain energy and apply it for loading condition.

Course Contents

Unit-I	**Simple Stress and Strain**	**(06 Hrs)**
Load, Direct or normal stress ,Direct strain, Sign convention for direct stress and strain ,Elastic materials, Hooke's law, Modulus of elasticity - Young's modulus, Tensile test, Ductile materials, Brittle materials, Poisson's ratio, Application of Poisson's ratio to a two-dimensional stress system, Shear stress, Shear strain, Modulus of rigidity, Relationship Between E, G and K, Double shear, Allowable working stress -factor of safety, Load factor, Thermal stresses.		
Unit-II	**Principal Stresses, Theories of Failure**	**(06 Hrs)**
Principal Stresses: Introduction to principal stresses with application, Transformation of Plane Stress, Principal Stresses, and planes (Analytical method and Mohr's Circle), Stresses due to combined Normal and Shear stresses. **Theories of Elastic failure:** Introduction to theories of failure with application, Maximum principal stress theory, Maximum shear stress theory, Maximum distortion energy theory, Maximum principal strain theory, Maximum strain energy theory.		

Unit-III	Shear Force and Bending Moment Diagram, Slope and Deflection	(06 Hrs)
Types of supports and beams, shear force (S.F.), bending moment (B.M.), S.F. and B. M. sign convention, S.F. and B.M. diagrams for beams carrying different loading conditions. Points of contra flexure, Relationship between S.F, B.M. and intensity of loading. Introduction, Simple bending theory, Neutral axis, Section modulus, second moment of area, Relationship between loading, S.F., B.M., slope and deflection, Double integration method, Macaulay's method for all loading conditions.		
Unit-IV	**Bending and Shear Stress in Beam**	**(06 Hrs)**
Bending stresses: Theory of simple bending, assumptions, derivation of flexural formula, second moment of area of common cross sections (rectangular, I, T, C) with respect to centroidal and parallel axes, bending stress distribution diagrams, moment of resistance and section modulus. **Shear stresses:** Concept, derivation of shear stress distribution formula, shear stress distribution diagrams for common symmetrical sections, maximum and average shears stresses, shear connection between flange and web.		
Unit-V	**Torsion**	**(06 Hrs)**
Simple torsion theory, Polar second moment of area, Shear stress and shear strain in shafts, Section modulus, Torsional rigidity. Principal stresses, Strain energy in torsion, Variation of data along shaft length-torsion of tapered shafts, Power transmitted by shafts. Stresses in solid circular shaft- Torsional load only, bending load only, combined torsional and bending, Combined Torsion and axial loading.		
Unit-VI	**Euler's Columns and Strain Energy**	**(06 Hrs)**
Concept of buckling of columns, derivation of Euler's formula for buckling load for column with hinged ends, concept of equivalent length for various end conditions, limitations of Euler's formula, Rankine's formula, safe load on columns. Strain energy: Strain energy due to axial load (gradual, sudden and impact), Strain energy due to self-weight.		

Term Work

Term work shall consist of following experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. Tension test for ductile materials
2. Tension test for brittle materials
3. Compression test for ductile materials
4. Compression test for brittle materials
5. Shear test for ductile materials
6. Shear test for brittle materials
7. Torsion test for ductile materials
8. Torsion test for brittle materials
9. Impact Test- IZOD and Charpy
10. Strain Gaugeand rosettes theory
11. Testing of hardness by Rockwell
12. Graphical simulation of
    a. Shear force and bending moment diagrams with different end conditions.
    b. Slope and deflection.
    c. Principal stresses through graphical and analytical method.

List of Assignments

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Simple stress and strain.
2. Principal stresses and strain.
3. Shear force and Bending moment diagram and slope and deflection
4. Stresses in beams, thick and thin cylinder
5. Torsion
6. Euler's column and strain energy method

List of Tutorial

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Stresses in simple bar, Elastic modulus and two-dimensional stress systems.
2. Normal, tangential and resultant stresses on any oblique plane inclined to normal plane by analytical and graphical method.
3. Shaft diameter and factor of safety by using theories of failure.
4. Shear and bending moments on cantilever and simply supported beam and draw SFD and BMD.
5. Slope and deflection at any section between beams by using Macaulay's method.
6. Stresses in beam and draw shear stress diagram and bending stress diagram.
7. Shaft diameter and stresses when shaft subjected to torsion, bending combined torsional and bending, combined torsional and axial loads.
8. Euler's column theory and strain energy.

Textbooks

1. A textbook of strength of material by R.K.Bansal

Reference Books

1. V. B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publication
2. J. E. Shigley, Mechanical Engineering Design, McGraw Hill
3. R. Subramanian strength of Material
4. S Ramamrutham, Strength of Material
5. R.K Rajput, Strength of materials

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. To prepare demonstration model of cantilever beam for the study of deflection in it.
2. To prepare demonstration model of simply supported beam for the study of deflection in it.
3. To prepare demonstration model of fixed beam for the study of deflection in it.
4. To prepare demonstration model of Overhang beam for the study of deflection in it.
5. To prepare the chart on relation between E, G, K with derivation.
6. To prepare demonstration model for studying strain energy with consideration of various conditions like impact load, sudden load, gradual load.
7. To prepare the chart on various concepts used in Principal Stresses& planes.
8. To prepare the chart on concept use in Mohr's Circle method using graphically & analytically.
9. To prepare the chart on Rules and guidelines use for drawing SFD & BMD.
10. To prepare the chart on finding bending stress for I cross-sections.
11. To prepare the chart on finding bending stress for T cross-sections.
12. To prepare the chart on finding bending stress for C cross-sections.
13. To prepare the chart on concepts used in solid &hollow shafts.
14. To prepare the chart and demonstration model of Euler's formula for buckling load.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	**Electronic Circuits**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/Week	Assignments Internal	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**04**

Course Prerequisites:-	1. Electronics Engineering Systems
Course Objectives:-	The objective of this course is to cover performance evaluation of various amplifiers by 1. Introducing a concept of the multistage amplifiers, parameter evaluation and related design aspects of multistage amplifiers with the help of derivations. 2. Teaching a concept of the feedback in the amplifiers, feedback topologies with the help of derivations and their advantages and disadvantages. 3. Gauging the efficiencies of various types of power amplifiers with the help of derivations. 4. Teaching a concept and design of the RC and LC oscillators with the help of derivations. 5. Analyze the biasing of BJT circuit and Amplifier 6. Classify different types of FET
Course Outcomes:-	On completion of the course, students will be able to 1. **Identify** applications of BJT 2. **Analyze** FET operations. 3. **Analyze** numerical to get values of the input impedance, output impedance, gain and bandwidth in a multistage amplifier. 4. **Analyze** numerical to get values of the input impedance, output impedance, gain and bandwidth of all the topologies in a negative feedback amplifier. 5. **Analyze** the efficiencies in power amplifiers. 6. **Analyze** numerical to get values of the oscillation frequencies of the RC and LC oscillators, and to design the oscillator for the given oscillations frequency.

Course Contents

Unit-I	**BJT Biasing**	**(06 Hrs)**
Need of biasing circuits, Analysis and design of BJT biasing circuits like fixed bias, collector to base bias, voltage divider bias, split-supply bias, Concept of DC load line, Concept of stability factor, Derivation of stability factor, Single stage amplifiers		
Unit-II	**Field Effect Transistor (FET) Biasing**	**(06 Hrs)**
Types of MOSFET, construction, VI characteristics, FET Biasing-Self Bias, Fixed Bias, Current Source Bias, JFET amplifiers-CS,CD and CG amplifiers, Application of MOSFET.		
Unit-III	**Multistage Amplifiers**	**(06 Hrs)**
Projectile Need of the Multistage amplifiers, Types of Multistage amplifiers-Cascade and Cascode, Cascade-Coupling methods, Frequency response, Parameter evaluation - Ri, Ro, Av, Ai & Bandwidth for general multi stage amplifier, Choice of the transistor configuration in cascade amplifier, Analysis & design of direct coupled, RC coupled (Low frequency, high frequency and medium frequency analysis), transformer coupled (Low frequency, high frequency and medium frequency analysis) amplifier. Darlington Amplifier, Design of Cascode amplifier.		
Unit-IV	**Feedback Amplifiers**	**(06 Hrs)**
Types of basic Amplifiers, Concept and types of feedback, Transfer gain with feedback, Negative feedback topologies with their block Schematics, Effect of negative feedback on Input impedance; Output impedance; Gain and Bandwidth with derivation, Analysis of one circuit for each feedback topology for input impedance, output impedance, gain and bandwidth.		

Unit-V	Power Amplifiers	(06 Hrs)
Need of Power amplifiers, classification; applications; advantages of power amplifiers - Class A, Class B, Class C, class D and Class AB. Operation of - Class A with resistive load; Transformer coupled class A Amplifier; Class B Push – pull; Class AB Complementary symmetry and Quasi – complementary. Efficiency analysis for Class A transformer coupled amplifier, Class B push – pull amplifier. Comparison of efficiencies of other configurations. Distortion in amplifiers; concept of Total Harmonic Distortion (THD).		
Unit-VI	**Oscillators**	**(06 Hrs)**
Concept of Positive feedback, Condition and principle of oscillations (Barkhausen criterion), Classification of oscillators, Design analysis of RC and LC oscillators, RC oscillators: Phase shift, Wien bridge Oscillators; LC Oscillators: Hartley, Colpitt's and Clap; Piezo-electric effect in crystals and Crystal Oscillator.		

List of Experiments:

1. To find the gain and bandwidth of a 2-stage CE RC coupled amplifier.
2. To find the gain and bandwidth of a 2-stage transformer coupled amplifier.
3. To find the gain of a direct coupled amplifier.
4. To find the gain and bandwidth of a voltage series negative feedback amplifier.
5. To find the gain and bandwidth of a voltage shunt negative feedback amplifier.
6. To find the gain and bandwidth of a current series negative feedback amplifier.
7. To find the gain and bandwidth of a current shunt negative feedback amplifier.
8. To study the response of a Class A direct coupled/ transformer coupled amplifier.
9. To study the response of a Class B power amplifier.
10. To find the oscillations frequency of the RC amplifiers-RC phase shift/ Wien bridge oscillator.
11. To find the oscillations frequency of LC amplifiers-Colpitt's Oscillator/Hartley Oscillator
12. To plot frequency response of tuned amplifiers.

List of Assignments: One assignment on each unit

Text Books:

1. S. Salivahanan and N Suresh Kumar, 'Electronic devices and circuits', Mc Graw Hill Education India Private Limited, Third Edition.

Reference Books:

1. Ramakant A.Gayakwad "Op-amps and Linear Integrated Circuit Technology"Fourth edition
2. Adel S. Sedra, Kenneth C. Smith " Microelectronic Circuits" Oxford series in Electrical and computer engineering

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

To prepare a demonstration model on:

1. Water Level Indicator.
2. LED Emergency Light.
3. Home Security System.
4. AC to DC converter.
5. Automatic Street Light controller
6. Rain Alarm
7. Flashing LED
8. Dancing Light
9. Voltage doubler.
10. Voltage regulator using Zener diode.
11. Reverse Current Protection using diode.

12. BJTs as a digital switch.
13. Cascode amplifier
14. Sine wave generator.
15. FET used as a Multiplexer.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	EMBEDDED SYSTEMS		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours/Week	Assignments Internal	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**05**

Course Prerequisites:-	Electronics Engineering Systems
Course Objectives:-	1. To familiarize students with architecture and features of typical Microcontrollers. 2. To learn interfacing of real world input and output devices and use Embedded C to interface the microcontrollers to various applications.
Course Outcomes:-	1. Use Hardware and software tools for microcontrollers. 2. Write programs using features of 8051 microcontroller. 3. Write programs using features of PIC microcontroller. 4. Develop interfacing of microcontrollers with real world devices.

Course Contents

Unit-I	**Introduction to Microcontrollers**	**(08 Hrs)**
Comparison of Microprocessor & Microcontroller. Difference between RISC & CISC architectures, Harvard & Von Neumann architectures. 8051 Microcontroller: architecture, family devices & its derivatives. Ports, registers, memory organization, Programming in Embedded C.		
Unit-II	**8051 Microcontroller features**	**(08 Hrs)**
Timers and its modes, Delay generation using timers, Serial Communication with RS232,Interrupt structure, Timers programming with interrupts, Programming in Embedded C.		
Unit-III	**Peripheral Interfacing With 8051**	**(08 Hrs)**
8051 based system design – Address decoding, data memory space Interfacing & Applications –LED, LCD, Stepper motor, DAC/ADC, Sensors, Keyboard. Programming in Embedded C.		
Unit-IV	**PIC Microcontroller**	**(08 Hrs)**
Comparison of Features of different PIC series, PIC 18F architecture, registers, memory Organization, oscillator options, BOD, power down modes and configuration bit settings, Port structure, interrupts & timers of PIC18F,All programs in embedded C.		
Unit-V	**Peripheral Interfacing With PIC-I**	**(08 Hrs)**
Interfacing of PIC18F with LED, Seven segment display, LCD and Keypad. Use of timers with interrupts, PWM generation. All programs in embedded C.		
Unit-VI	**Peripheral Interfacing With PIC-II**	**(08 Hrs)**
MSSP structure, CCP and ECCP, Study of UART, SPI, I2C, ADC. Interfacing serial port, ADC, RTC, EEPROM. Motor Control using PIC. All programs in embedded C.		

List of Experiments:

1. BCD to HEX, HEX to BCD conversion in 8051
2. Generate BCD up/ down counter in 8051.
3. Square wave generation using timers in 8051.
4. Serial Communication using 8051.
5. LCD interfacing with 8051.
6. Stepper motor interfacing with 8051.
7. Keyboard interfacing with 8051.

8. ADC/DAC interfacing with 8051.
9. Serial Communication using PIC.
10. LCD interfacing with PIC.
11. Stepper motor interfacing with PIC.
12. Keyboard interfacing with PIC.
13. Seven segment display interfacing with PIC.

List of Assignments: One assignment on each unit
Content Delivery Methods: Chalk & talk, Power point presentation

Text Books:

1. Mazidi, "8051 microcontroller & embedded system" 3rd Edition ,Pearson
2. Mazidi, "PIC microcontroller & embedded system" 3rd Edition ,Pearson

Reference Books:

1. Ajay V. Deshmukh, "Micro-controllers - Theory and Applications", Tata McGraw Hill.
2. Kenneth J. Ayala, "The 8051 Micro-controller – Architecture, Programming & Applications", Penram International & Thomson Asia, Second Edition.
3. John B. Peatman, "Design with PIC Micro-controllers", Pearson Education Asia, Low Price Edition.
4. 18F xxx reference manual

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

To prepare a demonstration model on:

1. Finger Print based attendance management system
2. LPG gas leakage detection system
3. Automatic motor control for filling water tank
4. Fire detection and alert system
5. Room temperature maintenance by automatically adjusting fan speed / AC
6. Home automation
7. Automatic maintenance of green house
8. Alcohol detection and alert family members in case of drunk and drive
9. Patient monitoring through GSM
10. Digital Notice board for college students
11. Line follower robot
12. Path follower robot
13. Public garden automation
14. Voting machine with digital display
15. Design Real Time Clock
16. Automatic City Street Lights control system

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	Data Structures and Algorithms		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Practical:- 04 Hours/ Week	Term Work	25 Marks	01
	Total	**25 Marks**	**01**

Course Contents

Unit 1	**Introduction to Data structures and Algorithms**	**(8 Hrs.)**
Introduction to data structure, Data representation, Abstract Data types, Primitive data types, Data structure and data types, Differences between data types. Program design. Algorithms and different approaches to designing an algorithm, Complexity, Big O notation, algorithm analysis, recursion. Sorting Bubble sort, Selection sort, Quick sort, Merge sort, Insertion sort.		
Unit 2	**Analysis of Algorithms**	**(8 Hrs.)**
Asymptotic notations and their significance, Running time of an algorithm, Time-complexity of an algorithm, Performance analysis of an algorithm, Analysis of iterative and recursive algorithms, Master theorem (without proof).		
Unit 3	**Data Structures**	**(8 Hrs.)**
Importance of data structures, Arrays, Stacks, Queues, Linked list, Trees, Hashing table, Binary Search Tree, Heaps.		
Unit 4	**Search Trees and Multiway Trees**	**(8 Hrs.)**
Binary tree, Linked and array representation of Binary tree, Binary search tree, Operation: Searching of a Node in a Binary tree, Insertion of a node in binary tree, deletion from a binary tree. Threaded binary tree, Forest. AVL trees **Multiway Trees:** Issues in large dictionaries, m-way search trees, Btrees, search insert and delete operations, height of B-tree, 2-3 trees, sets and multisets in STL		
Unit 5	**Graphs Algorithms**	**(8 Hrs.)**
Definition, terminology, directed and undirected graphs, properties, connectivity in graphs, applications, implementation – adjacency matrix and linked adjacency chains, graph traversal – breadth first and depth first, minimum spanning tree (MST), single source shortest paths.		
Unit 6	**Algorithm Design Paradigms**	**(8 Hrs.)**
Divide and Conquer, Brute force, Greedy, Recursive Backtracking and Dynamic programming.		

Text Books:

1. "Data structure using C" ISRD group, TMH.
2. "Data Structure through C" ,Yashwant kanetkar, BPB Publication.
3. Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms, Third edition, MIT Press, 2009.

Reference Books:

1. "Data structure using C" AM Tanenbaum, Y Langsam and MJ Augustein, Prentice Hall India.
2. "Data structure and Algorithm Analysis in C" Weiss, Mark Allen Addison Wesley.
3. "Data structure – A Pseudocode Approach with C", Richard F Gilberg Behrouz A. Forouzan, Thomson
4. "Let us C", Yashwant Kanetkar,BPB Publication.
5. SanjoyDasgupta, C.Papadimitriou and U.Vazirani , Algorithms, Tata McGraw-Hill, 2008.
6. A. V. Aho, J.E. Hopcroft and J. D. Ullman, Data Strucures and Algorithms, Pearson India, Ist Edition, 2006
7. Sara Baase, Allen Van Gelder, Computer Algorithms, Introduction to Design and Analysis, 3rd edition, Wesley Longman Publishing, 1999.

List of Experiments:

1. Extract the features based on various color models and apply on image and video retrieval
2. Arrays, loops and Lists
3. Stacks and Queues
4. Searching and Sorting

5. Linked List and operations
6. Brute force technique
7. Greedy Technique
8. Backtracking
9. Dynamic Programming
10. Trees and Tree Operations
11. BFS and DFS
12. Minimum Spanning Tree

Designation of Course	MATLAB Programming		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Practical: -02 hours/Week	Term Work & Practical	50 Marks	01
	Total	**50 Marks**	**01**

Course Prerequisites:-	Basic Mathematics
Course Objective: -	The goal of the course is that students should develop techniques for problem solving using a programming language.
Course Outcomes	Students should 1. **Understand** basics of MATLAB and **apply** that knowledge to write simple programs. 2. **Understand** the concept of arrays and functions and be able **apply** them in writing programs/solving problems. 3. **Understand** the concept of 2D graphics and be able **apply** them in developing 2D plots 4. **Understand** the concept of 3D graphics and be able **apply** them in developing 3D plots 5. **Apply** MATLAB knowledge to solve algebraic problems 6. **Understand** the concepts of GUI and **apply** them in creation of forms and objects

Course Contents

Unit-I	**Introduction to MATLAB**	**(04 Hrs.)**
MATLAB Introduction; Platform & Features; Advantages & Disadvantages; MATLAB Commands; MATLAB Environment; Working with Variables & Arrays Workspace, Variables, & Functions; MATLAB Data Types; Control Statements; if...end statement; if-else... end statement; MATLAB switch; Loops: for loop; while loop; break and continue		
Unit-II	**Arrays and Functions**	**(04 Hrs.)**
Matrices & Arrays; Multi-Dimensional Arrays; MATLAB Compatible Array; MATLAB Sparse Matrices; MATLAB M-Files; MATLAB Functions; Anonymous Function		
Unit-III	**Graphics I: 2D plots**	**(04 Hrs.)**
fplot(); Semilogx(); Semilogy(); loglog(); Polar Plots(); fill(); Bar(); errorbar(); barh(); plotyy(); area(); Pie(); hist(); stem(); Stairs(); compass(); comet(); contour(); quiver(); pcolor();		
Unit-IV	**Graphics I: 3D plots**	**(04 Hrs.)**
plot3(); fill3(); contour3(); surf(); surfc(); mesh(); meshz(); waterfall(); stem3(); ribbon(); sphere(); ellipsoid(); cylinder(); slice()		
Unit-V	**Algebra in MATLAB**	**(04 Hrs)**
Gauss & Gauss-Jordan Elimination; Eigenvalues & Eigenvectors; Symbolic Mathematics, Polynomials and Interpolation		
Unit-VI	**GUI in MATLAB**	**(04 Hrs.)**
Components, Containers, Callback		

Term Work

Term work shall consist of programs and assignments based on syllabus.

1. Introduction to MATLAB commands and Programming
2. Use of Arrays and functions in command prompt and programming
3. Generation of 2D graphs
4. Generation of 3D graphs
5. Solving algebraic problems using MATLAB
6. Creation of GUI forms and objects

Text Books

1. “Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers”, Rudra Pratap, Oxford University Press

Reference Books

1. “MATLAB and its Applications in Engineering”, Barbara Johnston, Prentice Hall of India, New Delhi.
2. " MATLAB: An Introduction with Applications ", Amos Gilet, Wiley Publication
3. " MATLAB Programming for Engineers ", Stephen Chapman, Cengage Learning India Pvt. Ltd.
4. " Fundamental Concepts of MATLAB Programming: From Learning the Basics to Solving a Problem with MATLAB (English Edition) ", Dr.Brijesh Bakariya, Dr.Kulwinder Singh Parmar, BPB Publications

Designation of Course	Vocational Course-I: Sensors, PLC & HMI: Basic Training		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
	Term Work & Oral	50 Marks	02
	Total	**50 Marks**	**02**

Course Prerequisites:-	Digital Electronics, Embedded systems, Power Electronics
Course Objectives:-	1. To introduce the student to the programmable logic controllers sensors. 2. To impart the knowledge of protocols & networking of PLCs 3. To introduce SCADA &DCS 4. To introduce HMI
Course Outcomes:-	1. **Understand** the general principles of sensors and transducers 2 **Understand** the requirements for networking of sensors 3. **Understand** the principle and working of advanced sensors 4. **Identify** the sensors for typical applications. 5. **Identify** the components of SCADA & DCS 6. **Identify** the components of HMI

Course Contents

Unit-I	**Fundamentals of Sensors**	**(8 Hrs)**
Performance terminology, static and dynamic characteristics of transducers, classification of sensors and transducers, signal processing and signal conditioning.		
Unit-II	**Sensors and Networking**	**(8 Hrs)**
Inductive, capacitive, magnetic, various types of photo sensors, detection methods, through-beam detection, reflex detection & proximity detection, ultrasonic and microwave sensors. Applications and understanding of the above sensors. **Networking**: Networking of sensors, control of manufacturing process, tracking- the meantime between operations interventions, tracking the yield and mean process time, detection of machining faults, diagnostic systems, resonance vibration analyzer, sensing motor current for signature analysis, temperature sensing.		
Unit-III	**Advanced Sensor Technologies**	**(8 Hrs)**
Laser production, characteristics of lasers, types of laser sensors, bar code sensors, benefits of bar coding, transponder, RFID (Radio Frequency Identification), electromagnetic identifier, optical encoders, color sensors, sensing principles, color theory, unit color measurement, colour comparator, color sensing algorithm, fuzzy logic color sensor. fuzzy logic for optoelectronic colour sensor in manufacturing. **Sensors in Flexible Manufacturing Systems:** Vision sensors, image transformations, robot visual sensing tasks, detecting partially visible objects, sensors in flexible manufacturing.		
Unit-IV	**Sensors for Special Applications**	**(8 Hrs)**
A multi objective approach for selection of sensors in manufacturing, cryogenic manufacturing applications, semiconductor absorption sensors, semiconductor temperature detector using photoluminescence temperature detectors using point-contact, sensors in process manufacturing plants, measurement of high temperature, robot control through sensors, other sensors, collection and generation of process signals in decentralized manufacturing system.		
Unit-V	**SCADA & DCS**	**(8 Hrs)**
Role of SCADA in Industrial Automation, SCADA System Configuration, RTU, Communication, Introduction to DCS, Architecture of DCS, Input and output modules, communication module, Specifications of DCS.		
Unit-VI	**Human Machine Interface**	**(8 Hrs)**
Different Types of Operator Interfaces: Textual, Graphical, Data Handling With HMI, Configuration and Interfacing to PLC and PC, Communication Standards- DF1, Ethernet, DH45, RS232, RS485, Profibus.		

Text Books:

1. “Sensors & control systems in manufacturing.”, Sabnesoloman, Mc-Graw Hill book Company Network, 1994
2. “Mechatronics” ,W, Bolton
3. “Programmable Logic Controllers, Principles and Applications”; John W. Webb, Ronold A Reis, 5th Edition, Prentice Hall of India Pvt. Ltd

References Books:

1. “Sensor Technology Handbook”, Jon S. Wilson
2. “Mechanical measurement”, N.L. Buck & T.G.Buck,
3. “Sensors and Transducers”, Ian Sinclair

Designation of Course	**Design and Analysis of Machine Component**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: -02 Hours/Week	Internal Assessment	40 Marks	
	Term Work & Oral	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites: -	1. Computer Aided Drafting and Visualization 2. Computer Aided Machine Drawing 3. Strength of Machine Components
Course Objectives: -	1. To study basic concepts of machine design. 2. To design and analysis different types of machine elements 3. To design of machine component for finite and infinite life and subjected to fluctuating load.
Course Outcomes: -	1. **Understand** the basic concept of machine design and **evaluate** dimensions of simple components. 2. **Understand** the fundamental concepts for design of shaft, keys and coupling and **evaluate** forces and dimensions. 3. **Understand** the concept of designing of Power Screws and Mechanical spring and **analyze** it for various applications. 4. **Understand** the basic concept of fluctuating loads and **Analyze** design of components under fluctuating loads. 5. **Understand** the concept of fasteners and threaded joints; and **analyze** when it is subjected to different loading conditions. 6. **Understand** the Design concept of welded & riveted joint;and **analyze** when it is subjected to different loading conditions.

Course Contents

Unit-I	**Introduction to Design and Design against Static Load**	**(08 Hrs)**
Introduction to Design: Need for component design, design process, Introductions to concurrent engineering, Design consideration for casting, forging & machined parts, hot & cold worked parts and welded assembly, Introduction to design for manufacture & assembly, **Design against Static Load:** Modes of failure, Factor of safety, Service factor, stress strain relationship, shear stress & strain, stress due to bending moment, Eccentric axial loading. Design of simple machine parts - Cotter joint, Knuckle joint and Levers, curved beam.		
Unit -II	**Shafts, Keys and Coupling**	**(08 Hrs)**
Introduction, Transmission Shafts, Shaft Design on Strength Basis, Shaft Design on Torsional Rigidity Basis, ASME Code for Shaft Design, Design of Hollow Shaft on Strength Basis, Design of Hollow Shaft on Torsional Rigidity Basis, Flexible Shafts **Keys**– saddle, sunk, feather, woodruff, square, flat, Kennedy key, key design, Types of keys, splines. **Couplings-** types of couplings, Design of rigid and flexible couplings.		
Unit-III	**Power Screws and Mechanical Spring**	**(08Hrs)**
Power Screws, Forms of Threads , Multiple Threaded Screws, Terminology of Power Screw, Torque Requirement—Lifting Load, Torque Requirement—Lowering Load, Self-locking Screw, Efficiency of Square Threaded Screw, Efficiency of Self-locking Screw, Trapezoidal and Acme Threads, Collar Friction Torque, Overall Efficiency, Coefficient of Friction, Design of Screw and Nut, Design of Screw Jack, Differential and Compound Screws, Re-circulating Ball Screw.		

Mechanical Spring: Types of Springs, Terminology of Helical Springs, Styles of End, Stress and Deflection Equations, Series and Parallel Connections, Design of Helical Springs, Concentric Springs, Helical Torsion Springs, Surge in Spring, Multi-Leaf Spring, Nipping of Leaf Springs, Shot Peening		
Unit-IV	**Design for Fluctuating Loads**	**(08 Hrs)**
Stress concentration factor and its Reduction, Stress concentration factor for various machine parts, Cyclic stresses, Fatigue and endurance limit, Notch sensitivity, Cumulative Damage in Fatigue, Design for finite and infinite life, Soderberg, Goodman, Modified Goodman& Gerber criteria.		
Unit-V	**Threaded Joints**	**(08 Hrs)**
Basic Types of Screw Fastening, Cap Screws &Setscrews, Bolt of Uniform Strength, Locking Devices, Terminology of Screw Threads, ISO Metric Screw Threads, Bolt under tension, Eccentrically Loaded Bolted Joints in Shear, Eccentric Load Perpendicular to Axis of Bolt, Eccentric Load on Base plate, Torque Requirement for Bolt Tightening, Dimensions of Fasteners, Design of Turnbuckle.		
Unit-VI	**Welded and Riveted Joints**	**(08 Hrs)**
Welded Joints- Welding Processes, Strength of Butt and Fillet Joints, Strength of Parallel Fillet Welds, Strength of Transverse Fillet Welds, Axially Loaded Unsymmetrical Welded Joints, Eccentric Load in the Plane of Welds, Welded Joint Subjected to Bending Moment and Torsional Moment, Welding Symbols **Riveted Joints-** Types of Rivet Heads and riveted Joints, Rivet Materials, Types of Failure, Strength Equations, Efficiency of Joint, Caulking and Fullering, Eccentrically Loaded Riveted Joint		

Term work

Term work shall consist of following experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. Symbolic representation of common machine components using Auto-CAD.
2. Design of machine components such as knuckle joint, cotter joint and lever (anyone) using CAD software.
3. Design of coupling system using CAD software.
4. Design of screw jack using CAD software.

Assignment

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Static loading
2. Design of shafts
3. Power screw
4. Mechanical springs
5. Design of fluctuating load
6. Design of threaded joints
7. Design of welded
8. Riveted joints.

Note: Design data book should be used extensively.

Textbooks

1. V. B. Bhandari, “Design of Machine Elements”, Tata McGraw Hill Publication Co. Ltd.
2. R. S. Khurmi And J.K. Gupta “Machine Design”, S Chand Publication.
3. Shigley J. E. and Mischke C. R., “Mechanical Engineering Design”, McGraw Hill Publication Co. Ltd.
4. Spotts M. F. and Shoup T.E., “Design of Machine Elements”, Prentice Hall International.

Reference Books

1. Black P.H. and O. Eugene Adams, “Machine Design”, McGraw Hill Book Co. Inc.
2. Willium C. Orthwein, “Machine Components Design”, West Publishing Co. and Jaico Publications House.
3. Hall A. S., Holowenko A. R. and Laughlin H. G, “Theory and Problems of Machine Design”, Schaum’s Outline Series.
4. Sharma C. S. and Purohit Kamlesh, “Design of Machine Elements”, PHI LearingPvt. Ltd.
5. D. K. Aggarwal & Sharma P. C., “Machine Design”, S.K Kataria and Sons
6. Gope P. C., “Machine Design: Fundamentals and Applications”, PHI LearingPvt. Ltd.
7. “Design Data- P. S. G.” College of Technology, Coimbatore.
8. V. B. Bhandari, “Design Data Book”, Tata McGraw Hill Publication Co. Ltd.

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. To develop Industrial/Real life application demonstration model of different types of Joints. (Cotter joint and Knuckle joint)
2. To observe the system where transmission of power takes place through shaft, Keys, coupling, like Transmission of power from motor to pump/generator/lathe machine/drilling machine. By selecting suitable materials, design the shaft, key and coupling. To prepare design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also to prepare bill of materials.
3. To develop a demonstration models of different types of couplings.
4. To develop a demonstration models of different types of keys.
5. To observe the system where transmission of power takes place through power Screws. (e.g. Lead screw of lathe, feed screws of machine tools, Clamping screws, Toggle Jack screw, etc.) Get the required information regarding effort, clamping force, etc., and selecting suitable materials design screw, nut and different simple components in assembly. To prepare design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also to prepare bill of materials.
6. To develop demonstration models of different types of springs.
7. To develop demonstration models of different types of threaded joints.
8. To develop demonstration models of different types of fasteners.
9. To develop demonstration models of different types of welded joints.
10. To develop demonstration models of different types of riveted joints.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	DIGITAL ELECTRONICS		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical:- 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**05**

Course Prerequisites:-	Electronics Engineering Systems
Course Objective	1. To present the Digital fundamentals, Boolean algebra and its applications in digital systems 2. To familiarize with the design of various combinational digital circuits using logic gates 3. To introduce the analysis and design procedures for synchronous and asynchronous sequential circuits 4. To explain the various semiconductor memories and related technology 5. To introduce the electronic circuits involved in the making of logic gates 6. To introduce memory operation is PLA
Course Outcomes:-	The students should be able to- 1. Use digital electronics in the present contemporary world. 2. Design various combinational digital circuits using logic gates. 3. Do the analysis and design procedures for synchronous and asynchronous sequential circuits. 4. Use the semiconductor memories and related technology. 5. Use electronic circuits involved in the design of logic gates. 6. To understand characteristics of PLDs, Semiconductor memories and their applications

Course Contents

Unit 1	**Digital Fundamentals**	**(08Hrs)**
Number Systems – Decimal, Binary, Octal, Hexadecimal, 1‘s and 2‘s complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map Minimization and Quine-McCluskey method of minimization		
Unit 2	**Combinational Circuit Design**	**(08Hrs)**
Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Multiplexer, Demultiplexer, Magnitude Comparator, Decoder, Encoder, Priority Encoder.		
Unit 3	**Synchronous Sequential Circuits**	**(08Hrs)**
Flip flops – SR, JK, T, D, Master/Slave FF – operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits – Design - Moore/Mealy models, state minimization, state assignment, circuit implementation – Design of Counters- Ripple Counters, Ring Counters, Shift registers, Universal Shift Register.		
Unit 4	**Asynchronous Sequential Circuits**	**(08Hrs)**
Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Pulse mode sequential circuits, Design of Hazard free circuits.		
Unit 5	**Digital Integrated Circuits**	**(08 Hrs)**
Digital integrated circuits: Logic levels, propagation delay, power dissipation, fan-out and fan-in,		

noise margin, logic families and their characteristics-RTL, TTL, ECL, CMOS		
Unit 6	**PLDs & Semiconductor Memories: Programmable logic devices**	**(08Hrs)**
Study of PROM, PAL, FPGA,PLAs. Designing combinational circuits using PLDs. **Semiconductor memories** **C**lassification and characteristics of memory, different types of RAMs, ROMs and their applications, Double Data Rate RAMs.		

List of Experiments-

Term work shall consist of **Minimum Eight** Experiments.

1. Implementation of Boolean functions using logic gates
2. Study of characteristics of typical 74 TTL / 74 CMOS family like: fan in, fan out standard load , noise margin & interfacing with other families
3. Half, Full Adder and subtractor using gates and IC's
4. Code conversion using digital IC's
5. Function implementation using Multiplxer and Demultiplexer
6. Sequence generator using MSJK flip flop IC's
7. Study of counters : Ripple , Synchronous , Ring , Johnson , Up-down counter and its application
8. Study of shift registers : Shift left , Shift right , parallel loading and Pulse Train generator
9. Study of Full Adder using half adder
10. Study of 2 bit comparator
11. BCD Adder/Subtractor with Decoder driver and 7 segment display

Text Books/ Reference Books

1. M. Morris Mano and Michael D. Ciletti, "Digital Design", 5th Edition, Pearson, 2014.

REFERENCE BOOKS

1. Charles H.Roth. "Fundamentals of Logic Design", 6th Edition, Thomson Learning, 2013.
2. Thomas L. Floyd, "Digital Fundamentals", 10th Edition, Pearson Education Inc, 2011
3. S.Salivahanan and S.Arivazhagan"Digital Electronics", Ist Edition, Vikas Publishing House pvt Ltd, 2012.
4. Anil K.Maini "Digital Electronics", Wiley, 2014.
5. A.Anand Kumar "Fundamentals of Digital Circuits", 4th Edition, PHI Learning Private Limited, 2016.
6. Soumitra Kumar Mandal " Digital Electronics", McGraw Hill Education Private Limited, 2016.

Assignments:

At least ONE assignment on each unit

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. Survey report of basic gates ICs 7432, 4011, 4050, 4070,4071,40106
2. Implement combinational logic Circuit of given Boolean Equation.
3. Implement Half Adderand Half Subtractor.
4. Implement Full Adder using two Half Adders
5. Build4-bit parallel Adder / Subtractor using IC.
6. Build Code Converters: Binary to Gray
7. Build Code Converters: Excess 3 to Binary)
8. Implement Two Bit Magnitude Comparator using IC 7485
9. Implement given combinational logic using MUX

10. Implement 7 segment decoder driver using IC 7447.
11. Build a Decade counterand Up-Down Counter.
12. Build a Shift Registers: SISO and SIPO
13. Implement the Johnson Counter and Ring Counter.
14. Survey Report on Static I/O and transfer Characteristic of TTL and CMOS.
15. Implement given Boolean Function using PLA.

(Function and Equation will be given by Subject Teacher)

Unit Tests

Unit Test-I	Unit-I,II,III
Unit Test-II	Unit-IV,V,VI

Designation of Course	**POWER ELECTRONICS AND DRIVES**		
Theory: 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: 02 Hours / Week	Internal Assessment	40 Marks	
Tutorial: 01 Hour/Week	Tutorial		01
	Term work & Oral	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites:-	Construction, Working Principle & Application of AC and DC motors Introductions to Electronic Components SCR , Diodes etc
Course Outcomes:-	1. Explore the basic knowledge of the components and dynamics related to electrical drives and also basics of Voltage source converters. 2. Explore the basic knowledge of the components and also basics of Current source converters. 3. Perform and understand the operation of solid state control using Inverters. 4. Analyze and understand the DC Drives. 5. Understand the various Induction motor drives in various applications. 6. Explore the synchronous motor drives as per the industrial point of view.
Course Outcomes:-	The students should be able to- 1. **Understand** the different types of convertors. 2. **Understand** the basic concepts of matrix converter and CSC. 3. **Understand** the basic concepts multilevel Inverters. 4. **Understand** the basic concepts DC drives and **apply** it for different applications. 5. **Understand** the basic concepts of Induction motor drives and its different types. 6. **Understand** the basic concepts of Synchronous Motor Drives and **apply** it for different applications.

Course Contents

Unit 1	**Converters**	**(06 Hrs.)**
Voltage Source Converters: Review of 3-ph-full wave bridge converter, operation and harmonics, 3 level voltage source converters. PWM converter. Generalized technique of harmonic elimination and voltage control. Advanced modulation techniques (space vector modulation, 3rd harmonic PWM) Comparison of PWM techniques. Converter rating.		
Unit 2	**Current source converters**	**(06 Hrs.)**
(i) Matrix Converter: 3×3 matrix converter, principle of working, mathematical treatment, comparison of matrix converter with multipulse converter. (ii) Self and Line commutated current source converter: Basic concepts of CSC, converters with self commutating devices.		
Unit 3	**Multilevel Inverters**	**(06 Hrs.)**
Multilevel concept, Types of multilevel Inverters, diode clamped multilevel inverter, flying-capacitors multilevel inverters, cascaded multilevel inverter, switching device currents, D.C. link capacitor voltage balancing, features of multilevel inverters, comparison of multilevel inverters. Applications of multilevel Inverter: Reactive power compensation Back to back intertie system.		
Unit 4	**DC Drives**	**(06 Hrs.)**
Single phase and 3 phase converter drives. Four quadrant Chopper drives, closed loop control of DC motor, Permanent magnet DC motor drives, DC Servo drives, applications.		

Unit 5	Induction Motor Drives	(06 Hrs.)
3 phase induction motor control, stator voltage control/rotor voltage control, voltage and frequency control, current control, closed loop control of 3-phase induction motor. Soft starters, comparison of variable frequency drives, Speed control by static slip power recovery, induction motor servo drives, applications.		
Unit 6	**Synchronous Motor Drives**	**(06 Hrs.)**
Voltage and frequency control, closed loop control of synchronous motors. Synchronous motor servo drive with sinusoidal waveform, synchronous motor servodrive with trapezoidal waveform. Load commutated invertor drives, speed control of synchronous motors by cyclo-convertors, applications.		

LIST OF EXPERIMENTS: (Students should perform at least 08 experiments from the following list)

1. Gate Pulse Generation using R, RC and UJT.
2. Characteristics of SCR and Triac
3. Characteristics of MOSFET and IGBT
4. AC to DC half controlled converter
5. AC to DC fully controlled Converter
6. Step down and step up MOSFET based choppers
7. IGBT based single phase PWM inverter
8. IGBT based three phase PWM inverter
9. AC Voltage controller
10. Switched mode power converter.
11. Simulation of PE circuits

(1Φ&3Φsemiconverter, 1Φ&3Φfullconverter, dc-dc Converters, ac voltage controllers).

Text Books:

1. Bimal K Bose, Modern power electronics and AC drives, Pearson education asia
2. G. K. Dubey, Fundamentals of Electrical Drives CRC press 2002
3. Vedam Subrahmanyam Electric Drives: Concepts &Appl Tata McGraw-Hill
4. Power electronics convertors, applications and design, Ned Mohan, Tore M Undeland, William P Robbins, Wiley India Pvt. Ltd., 2009

5 E. Acha, Miller & Others, Power Electronic Control in Electrical Systems (Newnes, Oxford publication) – first Edition

6 M. H. Rashid Power Electronics, Prentice Hall of India Pvt. Ltd. New Delhi, (3rd Edition)

7. R Krishnan, Electric motor drives, modeling, analysis and control, PHI learning Pvt. ltd. 2001
8. S.K. Pillai, A first course in electrical drives, Newage international publishers. 2010

Reference Books and Papers:

1. E. H. Watanube, R.M. Stephen and Maurico Ardes "New Concepts of instantaneous active and reactive powers in Electrical systems with Generic loads" (IEEE transaction on Power Delivery Vol.8, no.2 April 1993, PP-697-703.
2. L. Benchaita, S. Sadaate and A. Salemnia – "A comparison of voltage source and current source shunt Active filter by simulation and Experimentation" (IEEE Transaction on Power Systems, Vol 14, No.2, May 99, PP 642-647.
3. H. Akagi, E.H. Watanabe and M. Aredes "Instantaneous Power Theory and Applications to Power Conditioning, IEEE Press, New York.

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. Review paper on applications of Power electronic switches with and without Snubber (i) IGBT (ii) MOSFET
2. Modeling and system simulation of basic electrical circuits using MATLAB-SIMULINK/SCILAB
3. Modeling and System simulation of basic power electronic circuits using MATLAB-SIMULINK/SCILAB
4. Development of AC Source with Single Diode fed Resistive and Resistive-Inductive Load
5. Development of AC source with Single SCR fed Resistive and Resistive-Inductive Load
6. Modeling and System Simulation of SCR based full converter with different types of load using MATLAB-Simulink/SCILAB
7. Development of prototype of Full converter fed resistive load
8. Development of prototype of Full converter fed Resistive-Back Emf (RE) load at different firing angles
9. Development of prototype of Full Converter fed Resistive-Inductive Load at different firing angles
10. Development of prototype of Full converter fed DC motor load at different firing angles
11. Circuit Simulation of Voltage Source Inverter and study of spectrum analysis with and without filter using MATLAB/SCILAB
12. Development of prototype of Single phase square wave inverter
13. Development of prototype of Three phase sine PWM inverter
14. Generation of PWM gate pulses with duty cycle control using PWM peripheral of microcontroller (TI-C2000 family/ PIC18)
15. Design of Driver Circuit using IR2110
16. Design and testing of signal conditioning circuit to interface voltage/current sensor with microcontroller (TI-C2000 family/ PIC18)
17. Design of PI controller using OP-AMP
18. PCB design and fabrication of DC power supply using any PCB design software (open source- KiCAD/students version)

Unit Tests

Unit Test-I	Unit-I,II,III
Unit Test-II	Unit-IV,V,VI

Designation of Course	**Manufacturing Technology-I**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: 02 Hours/Week	Internal Assessment	40 Marks	
	Term work	50 Marks	01
	Total	**150 Marks**	**04**

Course Prerequisites:-	The student should have basic knowledge of 1. Mechanical engineering system 2. Engineering materials 3. Advanced metallurgical technology
Course Objectives:-	The student should 1. To acquire the knowledge of Foundry Technology. 2. To acquire the knowledge of hot and cold working processes. 3. To acquire the knowledge of lathe, drilling, milling, and sheet metal operations.
Course Outcomes:-	The students should be able to– 1. **Understand** the pattern and mold making. 2. **Understand** the **v**arious casting processes and **apply** the best casting process for a specific product. 3. **Understand** the hot working and cold working processes and **apply** them in Manufacturing. 4. **Understand** different operations on lathe machine and **apply** them to create the job. 5. **Understand** different operations of drilling machine and milling machine and **apply** them to create the job. 6. **Understand** various sheet metal operations and **apply** them to create the job.

Course Contents

Unit 1	**Pattern and Mould Making**	**(06 Hrs.)**
Introduction to casting, Foundry Layout, Foundry departments and sections, Pattern and pattern making, Design and allowances for patterns, Colour codes for patterns, Storage of patterns. Moulding sand and core sands, Sand control test, Core and core making –Introduction, Core making Procedure, Types of cores, Core print, Core boxes. Mould and mould making-Moulding Methods, Moulding processes, Design of Gating System.		
Unit 2	**Sand Casting and Die Casting Practice**	**(06 Hrs.)**
Sand Casting Practice: Melting furnaces and their selection, Cupola furnace, Induction melting furnaces, Advantages, Limitations, applications, pouring practice and equipment's, Ladle technology, Strike out, Fettling, Cleaning and Surface preparation of castings, Defects in castings. Die Casting Practice: Pressure and gravity die casting, Shell mould casting, Investment casting, Continuous casting, centrifugal casting, Applications, Merits and limitations.		
Unit 3	**Hot and Cold Working Processes**	**(06 Hrs.)**
Hot Working Processes: Principle rolling, forging - drops, press, upset. Rolling, forging- extrusion, drawing, spinning, Angle of Contact of rolling, effect of hot working. Cold Working Processes: Cold rolling, swaging, forges extrusion- forward backward impact. Roll forging, tube drawing, wire drawing, spinning, shot peening, high energy rate forming, Stresses in wire drawing operations.		
Unit 4	**Introduction to sheet metal Working**	**(06 Hrs.)**
Introduction to machines in sheet metal Industry: shearing machine, bending machine, circular profile cutting machines. Rivets and its different parts, Punching, blanking, shearing, bending, and piercing. Punch & Die tolerance and clearance. Introduction to Dies: Simple Dies, Compound Dies, Progressive Dies. Types of presses.		

Unit 5	Theory of Metal Cutting	(06 Hrs.)
Introduction of Lathe, function, types, construction, accessories, operations, thread cutting, single and multi-start thread cutting different tools, tool materials, Tool Geometry- Single Point cutting tool, Tool Wear and Tool Life, Mechanics of Metal cutting- Merchant's Circle Diagram, concept of speed, feed, depth of cut. Introduction to Boring Machines- general arrangement and nature of work done.		
Unit 6	**Drilling Milling and Grinding Machines**	**(06 Hrs.)**
Drilling Machines: Fundamentals of drilling process, twist drill geometry, tool holders, Types of drilling machines, drilling operations. Types of drills, reaming process. Milling Machines: Fundamentals of milling process, cutters-types and geometry, Operations performed on milling machines. Dividing head, methods of indexing, Introduction to grinding Machines.		

Assignments:

1. Pattern and Mould Making.
2. Sand Casting and Die Casting Practice.
3. Hot Working processes and Cold Working Processes.
4. Turning, boring related process.
5. Drilling Machines.
6. Milling Machines.
7. Rivets and its different parts.
8. Punch & Die tolerance and clearance.

List of Experiments: (Any Eight)

1. Moulding and core sand testing (Clay content test, moisture content test etc.).
2. Strength of Green sand mould and greens sand core.
3. Mold Making Practice.
4. Job on drilling, reaming, tapping.
5. Casting of component by using green sand molding / Die casting.
6. Individual job on center Lathe.
7. Study of dividing indexing mechanism on milling machine.
8. Gear cutting job on Milling Machine.
9. Study and demonstration of Grinding Machines.
10. Job on sheet metal working.

Text Books:

1. O. P. Khanna, A text book of Foundry Technology, Dhanpat Rai and Sons
2. P. C. Sharma, Production Engineering, S. Chand Publications
3. R. K. Jain, Production Technology, Khanna Publishers

Reference Book

1. P. N. Rao, Manufacturing Technology- Vol 1, McGraw Hill Education (India) Private Limited
2. P. N. Rao, Manufacturing Technologyp, Vol- II, McGraw Hill Education (India) Private Limited
3. G. R. Nagpal, Tool Engineering and Design, Khanna Publishers
4. B. S. Raghuwanshi, Workshop Technology, Vol-II, Dhanpat Rai & Co.
5. Hajra Chaudhari, Workshop Technology, Vol.-II
6. Roy A. Lindberg, Process & Materials of Manufacture, PHI
7. E. P. DeGrmo, J. T. Black and A. Kosher, Material and processes in manufacturing, PHI
8. HMT Handbook, Production Technology, TMH

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. Working model of all types of patterns
2. Different types of gates in casting process
3. Different types of runners layout
4. Design and working model of gating system for any simple mechanical component
5. 2D model for detailed sand casting process
6. 2D model for detailed die casting process
7. Selection criteria, detail specifications, brands available in market and cost comparison of pressure and gravity die casting machine
8. Selection criteria, detail specifications, brands available in market and cost comparison of shell moulding
9. Selection criteria, detail specifications, brands available in market and cost comparison of centrifugal casting
10. Selection criteria, detail specifications, brands available in market and cost comparison of rolling machines
11. Selection criteria, detail specifications, brands available in market and cost comparison of wire drawing
12. Selection criteria, detail specifications, brands available in market and cost comparison of forging machine
13. Design and working model of simple die
14. Design and working model of compound die
15. Design and working model of combination die
16. Design and working model of progressive die
17. Selection criteria, detail specifications, brands available in market and cost comparison of lathe machine
18. Selection criteria, detail specifications, brands available in market and cost comparison of drilling machine
19. Selection criteria, detail specifications, brands available in market and cost comparison of milling machine
20. Selection criteria, detail specifications, brands available in market and cost comparison of CNC machine

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	AUTOMATIC CONTROL SYSTEMS		
Teaching Scheme:	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: 02 Hours/Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**05**

Course Prerequisites: -	1. Mathematics & Science 2. Basic Electrical Engineering. 3. Sensors and Measurement System.
Course Objectives: -	1. Familiarization with Control System Principles and Applications of Control System. 2. Calculate and Estimate the Stability Measures, Time Response Measures from the Analysis of Mathematical Models of Some Simple Engineering Systems. 3. Develop Data Acquisition System using Controllers and apply it for Industrial Automation Application.
Course Outcomes: -	The students should be able to 1. Understand the basic concepts of automatic control systems 2. Obtain an overall transfer function of control system by using block diagram algebra methods 3. Determine the time and frequency response of control systems 4. Determine the (absolute) stability of a closed-loop control system using Routh-Hurwitz's stability criterion. 5. Apply fundamentals of PID controllers and use it in industrial automation 6. Select and use control system components for industrial automation.

Course Contents

Unit-I	**Introduction to Automatic Control systems**	**(08 Hrs.)**
Open Loop system, Closed Loop system, Conversion of an Open Loop system to a Closed Loop system, Servo Mechanism, Feed Forward Systems, Adaptive Control Systems, Classification of Control Systems, the design process. Transfer Function, Concept of Poles & Zeros of a Transfer Function, Properties of Transfer Function, Transfer Function of Basic Devices; Mathematical Modelling of Mechanical and Electrical Systems. Mechatronics System & Its Examples, Mechatronics System Components.		
Unit-II	**Block Diagram Representation**	**(08 Hrs.)**
Block Diagram Definitions, Generating a Block Diagram from a Physical System, Canonical Form, Rules for Block Diagram Reduction, Reduction of Block Diagram, Reducing to Unity Feedback Systems, Examples on Block Diagram Reduction.		
Unit-III	**Time Response and Frequency Response Analysis**	**(08 Hrs.)**
Time response of control system, standard test signal, Time Response, Analysis of First and Second order system, Time Domain specifications. Step response of second order system. Steady-state errors, static error constants, steady state, analysis of different type of Systems using step. Ramp and parabolic inputs, Frequency Response Specification, Co-relation between Time and Frequency Domain		
Unit-IV	**Stability Analysis**	**(08 Hrs.)**
Stable system, Unstable System, Marginally Stable System, Time Response of Poles, Hurwitz Stability Criterion, Routh Stability Criterion, Routh Criterion Special Cases, Relative Stability, Application of Routh's Criterion.		
Unit-V	**Controllers**	**(08 Hrs.)**
Introduction to Controllers, Control System Parameters, Controller Modes, Control Actions, Types of		

Controllers-ON-OFF Controller, Proportional Controller (P-Controller), Proportional + Integral Controller(P-I Controller), Proportional + Derivative Controller (P-D Controller), Proportional +Integral+ Derivative Controller (P-I-D Controller), Effect of Proportional, Integral, and derivative control on the Time Response of the System		
Unit-VI	**Control System Components**	**(08 Hrs.)**
Data Acquisition: Elements of a Data Acquisition and Control System, Overview of the Input/Output Process, Analog to Digital (A/D) Conversion, Digital to Analog (D/A) Conversion, Data Acquisition Case Studies. Variable Frequency Drive, Servomotor. **Switches:** Construction, symbolic representation, working, application of Toggle switch, Slide switch, DIP switch, Rotary switch, Thumbwheel switch, Selector switch, Push button, Drum switch, Limit switch, Temperature switch, Pressure switch, Level switch, Flow switch. **Relays:** Construction, working, specifications/selection criteria and applications of electromechanical relay, Reed relay, hermetically sealed relay, Solid state relays. **Contactors:** Construction, working, specifications and applications of contactors. Comparison between relay& contactor.		

Term Work:

Term work shall consist record of minimum 8 experiments from the following;

1. Analysis of following control system parameters using software like MATLAB/SIMULINK
    a. Plot the pole-zero configuration in s-plane for the given transfer function
    b. Stability analysis of given control system using Routh-Hurwitz's criterion
    c. Determine the transfer function for given closed loop system in block diagram representation.
    d. Plot unit step response of given transfer function and find peak overshoot, peak time, rise time and delay time.
2. To study the basic Open and Closed Loop Control system
3. To study the Water Level Control Using Industrial PLC
4. Determination of step & impulse response for a first order unity feedback system
5. Study of P, P+I, P+D, P+I+D control actions using any Trainer Kit / Simulation Software.
6. Study of A/D and D/A Converters.
7. Study the functions and applications of variable frequency drive (VFD).
8. Study the functions and applications of AC servomotor.
9. Study of various switches, Relays and Contactors.
10. Study of Data Acquisition System and Interfacing of sensors with computer using DAQ Cards
11. Identification of different control system components in PLC based mini assembly cell

Text Books/Reference Books:

1. K. Ogata, Modern Control Engineering, Prentice Hall of India, 3rd edition, 1998
2. I.J. Nagarath and M. Gopal, Control Systems Engineering , New Age International (P) Ltd.
3. M. Gopal, Digital Control and State Variable Methods, Tata Mc Graw-Hill Companies, 1997.
4. Stainslaw H. Zak, Systems and Control , Oxford Press, 2003.

5. M. Gopal Modern Control System Theory, New Age International Publishers, 2nd edition, 1996.
6. W. Bolton, "Mechatronics", Pearson Education.
7. Ramchandran K. P., Vijyaraghavan G. K., Balasundaram M. S., "Mechatronics: Integrated Mechanical Electronic Systems", John Wiley & Sons, 2008.
8. Kumar D. S., "Mechanical Measurement & Control", Metropolitan Book Co. Pvt. Ltd. New Delhi, 2007
9. Singh M. D. and Joshi J. G., "Mechatronics", 3rd Edition, Prentice Hall, New Delhi, 2009.

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. Prepare a simple circuit for Open Loop Control systems for any Engineering application
2. Prepare a simple circuit for Closed Loop Control systems for any Engineering application
3. Prepare a simple working model which depicts an application of Mechatronics System
4. Generate a Block Diagram Algebra for any Mechanical System using Block Diagram Algebra rules.
5. Prepare Mathematical Model of any simple Mechanical Systems using MATLAB
6. Prepare a MATLAB Code to find the Time Response of Control system.
7. Solve the any Control system Characteristics equation for Stability Analysis using MATLAB
8. Prepare a simple control industrial application using Proportional Controller using any simulation software
9. Prepare a simple model which depicts the application of PID Controller using any simulation software
10. Prepare a circuit which depicts the operation of Analog to Digital Converter
11. Prepare a circuit which depicts the operation of Digital to Analog Converter
12. Identify Mechatronics Systems from Day-to-Day Applications and mention all the system components used
13. Prepare a simple circuit which depicts application of different Switches
14. Prepare a simple circuit which depicts application of different Relays
15. Prepare a simple circuit which depicts application of different Contactors
16. Prepare a simple Data Acquisition System and Interfacing of sensors with computer for temperature sensors
17. Prepare a simple Data Acquisition System and Interfacing of sensors with computer for Load Cell
18. Prepare a Model to control water level in Tank

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	Solid Modelling		
Teaching Scheme:	**Examination Scheme**		**Credits Allotted**
Practical:- 04 Hours/Week	Term Work & Practical	50 Marks	02
	Total	**50 Marks**	**02**

Course Prerequisites: -	1. Computer Aided Drafting and Visualisation 2. Computer Aided Machine Drawing
Course Objectives: -	1. To introduce students to the basic concepts of CAD modelling. 2. To develop the skills in Reading and Interpretation of Engineering Drawings. 3. To familiarize students with modeling Software to Crate 2D and 3D model, Assembly, Drafting and Sheet metal modelling.
Course Outcomes: -	The students will be able to 1. **Understand** the concepts of CAD modelling. 2. **Creating** 3D machine components using Modeling Software. 3. **Creating** Assembly of machine components using Modeling Software. 4. **Creating** surface model of Automobile Components using Modeling Software. 5. **Creating** detail drawing and generating Bill of Material using Modeling Software. 6. **Understand** the basic concepts of Sheet metal Modelling and **Create** a machine component using modeling Software.

Course Contents

Unit-I	**Introduction to CAD**	**(08 Hrs.)**
Introduction to CAD and CAE Features, Various products available for Product Design, Simulation, Communication modeling Graphical User Interface - Feature manager design tree, Callouts, Handles, Confirmation corner, mouse buttons, keyboard shortcuts, Command Manager. Sketch Entities, Sketch Tools, Block, Relation and Dimensioning.		
Unit-II	**Basic Part Modelling**	**(08 Hrs.)**
Part Modelling Tools, Creating Extrude features, Creating Revolve features, Creating Swept features, Creating Loft features, Creating Reference, Creating curves, Fillet features, Inserting Hole types, Creating Chamfer, Shell, rib, pattern and advanced modelling tools.		
Unit-III	**Assembly modelling**	**(08 Hrs.)**
Introduction to Assembly Modelling & Approaches, Applying Advanced Mates and Mechanical Mates, Manipulating Components, Creating Pattern, Creating Explode Views.		
Unit-IV	**Surface Modelling**	**(08 Hrs.)**
Surface Modelling tools Creating Extrude, Revolve, Swept, loft, Boundary surface. Inserting Planar Surface, Offset Surface, Radiate Surface. Extending a surface, Surface fill, Ruled Surface, Trimming Surface, Mid surface, Replace Face, Delete face, Un-trim surface, Knit surface, Thickening a Surface, Move Face.		
Unit-V	**Drafting of Mechanical Systems**	**(08 Hrs.)**
Generating Views, Creating Dimensions, Inserting Annotations and Bill of Materials.		
Unit-VI	**Sheet Metal Modelling**	**(08 Hrs.)**
Constructing the base flange and miter Flange, addition of an Edge Flange, closing corner, Adding Jog, Unfolding the bends, Adding hem and vent.		

Term Work

Term work shall consist of A-3/A4 size printouts of the problems solved in practical's using Solid Works Software.

1. Sketcher drawings
2. Part modelling
3. Parametric Modelling
4. Assembly Modelling
5. Exploded view of Assembly
6. Surface Modelling
7. Drafting of Mechanical Systems
8. Sheet metal modelling

Text Books

1. Kuang-Hua Chang, "Motion Simulation and Mechanism Design with MODELING Motion 2018", SDC Publishers, 2018

Reference Books

1. Ibrahim Zeid and R. Siva-Subramaniam – "CAD/CAM- Theory and Practice", Tata McGraw Hill, Publishing Co. 2009.
2. Rao P. N., "CAD/CAM", Tata McGraw Hill.
3. Foley, Van Dam, Feiner and Hughes, "Computer Graphics Principles and Practice", Second edition, Addison–Wesley, 2000.
4. Martenson, E. Micheal, "Geometric Modelling", John Wiley & Sons, 1995.
5. Ronald E. Barr, DavorJuricic, Thomas J. Krueger, "Engineering & Computer Graphics Workbook Using Modeling 2014", SDC Publication, 2014.
6. John Willis, Sandeep Dogra, "MODELING 2019: A Power Guide for Beginners and Intermediate User", published by CADArtifex, 2019.

End Semester Practical/Oral examination:

1. Practical examination duration is Two hours, based on the Term work.
2. Questions provided for practical examination should contain minimum five and not more than ten parts.
3. Evaluation of practical examination to be done based on the performance of students work in laboratory.

***Oral examination should also be conducted to check the knowledge of conventional and Solid Works drawing.**

Designation of Course	Vocational Course-II: PLC, HMI & Automation: Advanced Training		
Teaching Scheme:	**Examination Scheme**		**Credits Allotted**
	Term Work & Oral	50 Marks	02
	Total	**50 Marks**	**02**

Course Prerequisites: -	C Programming
Course Objectives: -	1. To introduce the functions of given industrial automation system. 2. To introduce input-output devices in PLC. 3. To introduce HMI and PLC interfacing
Course Outcomes: -	1. Understand the functions and characteristics of given industrial automation system 2. Interface the given I/O device with appropriate PLC module 3 .Understand working of HMI 4. Indentify HMI hardware and software. 5. Interface PLC & HMI. 6. Understand the control panels of various industry HMIs

Course Contents

Unit-I	**Introduction to Industrial Automation**	**(08 Hrs.)**
Need and benefits of Industrial Automation, Automation Hierarchy, Basic components of automation system, description of each component, Types of automation system:-Fixed, programmable, flexible, Different systems for Industrial automation: PLC, HMI, SCADA, DCS, Drives		
Unit-II	**PLC Programming and Applications**	**(08 Hrs.)**
PLC I/O addressing, PLC programming Instructions : Relay type instructions, timer instructions: On delay, off delay, retentive. Counter instructions, Up. Down. High speed, Logical instructions, Comparison Instructions, Data handling Instructions. Arithmetic instructions, PLC programming language-Functional Block Diagram (FBD). Instruction List, Structured text, Sequential Function Chart (SFC), Ladder Programming, Simple Programming examples using ladder logic: Language based on relay, timer counter, logical, comparison, arithmetic and data handling instructions PLC based applications: Motor sequence control, Traffic light control, elevator control, Tank level control, conveyor system, Stepper motor control, reactor control		
Unit-III	**Human Machine Interface (HMI)**	**(08 Hrs.)**
History of User Interface Designing, I/O channels, Hardware, Software and Operating environments, The Psychopathology of everyday Things, Psychology of everyday actions, Reasoning and problem solving . The computer: Devices, Memory, processing and networks. Interaction: Models, frameworks, Ergonomics, styles, elements, interactivity, Paradigms, Security Features of HMI		
Unit-IV	**HMI Selection and programming**	**(08 Hrs.)**
HMI Interfacing Considerations, HMI Hardware Selection, HMI Software Selection, HMI Ergonomics, Configuring System Communications, Security Delta HMI programming: Communication to PLC Tags, Alarms, Trends, DataLog Screens, Animation. Download / upload Making Applications Download & Upload the Programs Creating Alarm Messages Communication with PLC Fault Finding and Trouble Shooting		
Unit-V	**PLC & HMI**	**(08 Hrs.)**
Communications - PLC to HMI, operator station design, Operator Interfaces Types, Textual, Graphical, animation, Interlocking tagging, HMI assembling and Wiring, HMI Data Handling		
Unit-VI	**HMI in Industries**	**(08 Hrs.)**
Role of HMI in Industries, Hardware & Architecture Source & Sink Concepts Wiring different field devices to PLC, Siemens KTP 600 Basic color PN (Key Touch Panel), Siemens TP177A DP (Touch Panel), Delta DOP-B07S411 (Touch Panel), Mitsubishi GS Series, HMI/SCADA development for the Pressure Control Station.		

Text Books:

1. Frank D. Petro Zella, "Programmable logic controller" McGraw – Hill Publications, 1998
2. PanelView32 and RSView32 Programming Guides, Rockwell Automation

References Books:

1. John B. Peatman, PIC programing, McGraw Hill International, USA, 2005
2. Programmable Logic Controllers, Principles and Applications: John W. Webb, Ronold A Reis, 5th Edition, Prentice Hall of India Pvt. Ltd
3. Stuart A. Boyer, SCADA supervisory control and data acquisition, ISA Publication

SIGNALS AND SYSTEMS

(Course No.)

Designation of Course	**Signal and Systems**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	-- Marks	
	Total	**125 Marks**	**05**

Course Prerequisites: -	The students should have knowledge of 1. Differential and Integral calculus 2. Vector algebra and algebra of complex numbers
Course Objectives:-	To provide Knowledge about 1. To understand the behavior of signals in time and frequency domain 2. To understand the characteristics of LTI systems 3. To analyze continuous and discrete time systems using different transform techniques.
Course Outcomes:-	Students will be able to 1. Classify signals and perform operations on signals. 2. Analyze LTI systems using convolution. 3. Apply Fourier series and Fourier Transform for analysis of signals. 4. Analyze CT signals and systems using Laplace transform. 5. Apply Z-transform for the analysis of DT signals and systems. 6. Sample and reconstruct the signals using sampling technique

Course Content

Unit I	**Introduction and Classification of signals**	**(08 Hrs.)**
Signals and Systems definition, Types of signals, continuous time and Discrete time signal operations, Amplitude scaling, Time shifting, Time reversal, Time scaling, Mathematical operations additions, subtraction, multiplication of signals, Classification of signals according to their property, Periodic/Aperiodic, Even/Odd, Energy/Power/Causal/Non causal, Deterministic/Random signals		
Unit II	**Time domain representation of LTI System:**	**(08 Hrs.)**
Introduction to systems, Classification of systems according to their properties, Linear/Nonlinear, Static /Dynamic, Time Invariant/Time variant, Causal/non causal, Stable/Unstable, Invertible/Non-Invertible systems, LTI system: Causality, stability, step response, impulse response, Convolution Integral, convolution sum using graphical method properties and applications.		
Unit III	**Fourier Analysis of Signals**	**(08 Hrs.)**
Fourier Series: - Review of Fourier series of CT and DT signals and its properties (No derivation), Exponential and Trigonometric Fourier series of periodic signals, Amplitude and phase spectra of periodic signals.		
Unit IV	**Application of Laplace Transform in Signal processing**	**(08 Hrs.)**
Review of Bilateral and Unilateral Laplace Transform of signals, ROC and its properties. Laplace transforms of standard signals, Inverse Laplace Transform, Solution to differential equation, System transfer function and Response calculations, Poles and Zeros representation		
Unit V	**Z-transform**	**(08 Hrs.)**

Z-transform, Region of convergence and its properties, Inverse z transform, properties of z transform, relation between Z and Laplace Transform, Analysis and characterization of discrete time LTI systems using z-transform.		
Unit VI	**Sampling and Correlation**	**(08 Hrs.)**
Sampling theorem, sampling, and reconstruction of signal from its samples using interpolation, Effect of under sampling, Correlation, Autocorrelation and cross-correlation of energy and power signals, properties of correlation functions, applications of Correlation, Energy Density Spectrum, Parsevals Theorem, Power Density Spectrum		

List of Practical /Term work: -

1. Introduction to MATLAB and its basic functions.
2. Generate Continuous and discrete time signals.
3. Perform signal operations on Continuous and discrete time signals.
4. Find even and odd part of the signal and sequence and find real and imaginary parts of signal.
5. Compute linear convolution and convolution integral of sequences/signals.
6. Compute Fourier Transform and Inverse Fourier Transform of a given signal/sequence and plot its Magnitude and Phase Spectra.
7. To compute and plot the impulse response and pole-zero diagram of transfer function using Laplace transform.
8. To compute and plot the impulse response and pole-zero diagram of transfer function using Z-transform.
9. Compute auto correlation and cross correlation between signals and sequences and verify its properties.
10. Verify sampling theorem and reconstruct the signal

Textbook: -

1. Oppenheim, Willsky, S.Hamid Nawab, “Signals and Systems”, PHI,2nd edition, 2002.
2. M.J. Roberts, “Signals and Systems”, McGraw-Hill, 1st edition,2003.
3. B.P Lathi, “Principles of linear systems and signals”, Oxford, 2nd edition,2009.

Reference Book:-

1. Simon Haykin and Bary Van Veen, “Signals and Systems”, Wiley- India Publications
2. Michal J. Roberts and Govind Sharma, “Signals and Systems”, Tata Mc-Graw Hill Publications

Project Based Learning

Students in a group of 3 to 4 shall complete any one project from the above list

1. Generate basic signals using C / Python programming.
2. Perform multiple operations on signal using C or MATLAB.
3. Visualize signal/data in time and frequency domain using MATLAB.
4. Find the Trigonometric Fourier Series of a given Signal using C/Python/MATLAB.
5. Create Frame-Based Signals using MATLAB simulink.
6. Create Multichannel Signals by combining single channel signals using simulink.
7. Create Multichannel Signals by combining multichannel signals using simulink.
8. Inspect sample and frame rate using simulink.
9. Perform Linear Convolution of two sequences using SCILAB.
10. Represent, Play and plot audio signals with different sampling frequencies using MATLAB.
11. Study of Signal Processing Sound Effects: Introducing a delay, creating an echo effect by repeating the signal, time scaling, time reversal, volume scaling.
12. Create acoustic environment in Simulink.

13. Develop a Python application to generate digital signals.
14. Perform measurement using spectrum analyzer using MATLAB Simulink.
15. Filter the frames of noisy wave using MATLAB.

Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

ROBOT KINEMATICS AND DYNAMICS
(Course No.)

Designation of Course	**Robot Kinematics and Dynamics**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial:- 01 Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**05**

Course Prerequisite:-	1. Concept of degree of freedom 2. Different types of mechanisms, robot coordinate system 3. Matrices and Algebraic Mathematics
Course Objective:-	To provide knowledge about 1. Different types of robot linkage, frame 2. Kinematics and Dynamics of Robot 3. Motion planning and control of robot manipulator
Course Outcomes:-	On completion of the course, students will be able to 1. Identify Elements of Robots 2. Calculate Kinematics of serial robot 3. Calculate Kinematics of parallel robot 4. Calculate Velocity and static analysis of robot 5. Evaluate dynamics behavior of robots 6. Evaluate Motion, trajectory of robotic arm

Course Content

Unit I	**Mechanisms in robots**	**(08 Hrs.)**
Position and orientation of a robot body such as roll, pitch, yaw, and, Degree of freedom for robot joint and linkages ,Different types of robot mechanism, Elements of robot Mechanism, Drive system used for robot mechanism, comparison of different robot mechanism, Types of wheel used in robots.		
Unit II	**Kinematics of serial robots**	**(08 Hrs.)**
Introduction, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Classical and Modified D-H Parameter, Matrix Manipulation Examples of D-H parameters and link transforms Direct and inverse kinematics problems, Examples of kinematics of common serial manipulators, workspace of a serial robot, Inverse kinematics of constrained and redundant robots, Inverse kinematics solution for the general 2- and 3-Dimensional serial manipulator.		
Unit III	**Kinematics of parallel robots**	**(08 Hrs.)**
Degrees-of- freedom of parallel mechanisms and manipulators, Active and passive joints, Constraint and loop closure equations, Direct kinematics problem, Closed-from and numerical solution, Inverse kinematics of parallel manipulators and mechanisms (theoretical treatment only)		
Unit IV	**Velocity and static analysis of robot manipulators**	**(08 Hrs.)**
Linear and angular velocity of links, Velocity propagation, Formation of Jacobian matrix, Manipulator Jacobians for serial and parallel manipulators, Velocity ellipse and ellipsoids, Singularity analysis for serial and parallel manipulators, Law of control for Second order system,		

Loss and gain of degree of freedom, Statics of serial and parallel manipulators, Singularity analysis and statics, Force analysis of robot system		
Unit V	**Dynamics of serial and parallel manipulators**	**(08 Hrs.)**
Mass/Inertia and their Positions of links, Lagrangian/Eularian/Newtonian/Screw Approaches for formulation of equations of motion for serial and parallel manipulators, Formation using, Lagrangian approach only, Generation of symbolic equations of motion using a computer, Simulation (Direct and Inverse) of dynamic equations of motion, Examples of a planar 2 link/joint and four-bar mechanism, Recursive dynamics, Numerical limited to 2 link and 2 joints (Revolute and Prismatic joint) planar robots		
Unit VI	**Motion planning and control**	**(08 Hrs.)**
Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link Simulation and experimental case studies on serial and parallel manipulators, Control of constrained manipulators, Cartesian control, Force control and hybrid position/force control, Advanced topics in non-linear control of manipulators		

List of Practical /Term work

Out of 10 and 8 experiments can be performed

1. Introduction to Robot Kinematic and Dynamics Analysis software and its commands
2. To study and prepare a model of Robot coordinate frames and transformations by using Robo Analyzer
3. To study and prepare a model of Forward kinematics of robot by using Robo Analyzer
4. To study and prepare a model of Inverse kinematics of robot by using Robo Analyzer
5. Workspace analysis of 6 Axis robot
6. Kinematic Analysis of MITSUBISHI Mini Robot
7. To study and prepare a model of Forward Dynamics of robot by using Robo Analyzer
8. To study and prepare a model of Inverse Dynamics of robot by using Robo Analyzer
9. To Create Robot Joint trajectories by using Robo Analyzer
10. Demonstration of Forward Kinematics by using motors

Project Based Learning

1. Prepare a model showing Forward Kinematics of Robot
2. Prepare a model showing Dynamics of Robot
3. Prepare a model showing Joint trajectories in robot linkages
4. Prepare a model showing Inverse Kinematics of Robot
5. Prepare a model Forward Kinematics by using motors

Textbook

1. 1.Groover M. P., “Industrial Robotics: Technology, Programming and Applications, Tata McGraw Hill Publication
2. Taghirad H.D, “Parallel Robots: Mechanics and Control”, CRC Press.
3. Moore S. W., Bohm H., and, Jensen V., “Underwater Robotics: Science, Design &Fabrication”, Marine Advanced Technology Education (MATE) Center, 2010
4. Bock T., Linner T., “Robot Oriented Design: Design and Management Tools for the Deployment of Automation and Robotics in Construction”, Cambridge University Press
5. Introduction to Robotics Dr. S.K.Shah

Refrence Book

1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, „Introduction to Autonomous

Mobile Robots‖, Bradford Company Scituate, USA, 2004
2. RiadhZiaer (Ed) „The future of Humanoid Robots- Research and applications‟, Intech Publications, 2012.
3. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.
4. Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, "Field and Service Robotics ", Springer, 2011.
5. Mejia O. D. M., Gomez J. A. E., (eds.), "Aerial Robots: Aerodynamics, Control and Application" InTech Open Publications.

Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

MANUFACTURING TECHNOLOGY –II

(Course No.)

Designation of Course	**Robot Kinematics and Dynamics**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**05**

Course Prerequisite:-	The student should have basic knowledge of 1. Basic knowledge of Manufacturing Processes. 2. Basic knowledge of Engineering materials and its properties 3. Basic knowledge of cutting tools
Course Objective:-	To provide knowledge about 1. To acquire the knowledge of Machining Processes and CNC technology. 2. To acquire the knowledge of Additive manufacturing processes and Flexible Manufacturing Systems 3. To acquire the knowledge Computer Aided Process Planning and Robotics in Manufacturing.
Course Outcomes:-	On completion of the course, students will be able to 1. Understand the various Non-conventional Manufacturing processes and apply them in manufacturing. 2. Understand the various CNC Programming and apply them for manufacturing of components. 3. Understand the use of Additive manufacturing and apply them to create the jobs. 4. Understand the Group Technology and FMS and apply them in manufacturing. 5. Understand the use of computer aided process planning and apply it for manufacturing purpose. 6. Understand various robotic applications in manufacturing.

Course Content

Unit I	**Advanced Machining Processes**	**(08 Hrs.)**

Mechanical Processes: Mechanical Processes: Ultrasonic machining (USM), Abrasive Jet Machining (AJM), Water Jet machining (WJM), Abrasive water Jet Machining (AWJM) processes- Process principle and mechanism of material removal, Process Parameters; Applications; Operational characteristics; Limitations.

Electro Chemical Processes: Electrochemical Machining Process (ECM) principle; Mechanism of material removal; Process Parameters; Process Capabilities; Applications, Tool Design, Electro Chemical Deburring (ECDE).

Thermal Processes: Electro discharge Machine (EDM), Wire Electro Discharge Machining (WEDM), Laser Beam Machining (LBM), Electron Beam Machining (EBM), Plasma Arc machining (PAM) processes–Process principle and mechanism of material removal; Process parameters and characteristics; Surface finish and accuracy, Applications; Limitations.

Unit II	CNC Technology	(08 Hrs.)
Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning Centre, machining Centre, CNC controllers, characteristics, interpolators– Computer Aided Inspection, CNC Programming: Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles, programming for machining Centre and turning Centre for well-known controllers such as Fanuc, Siemens. Introduction to CMM.		
Unit III	**Additive Manufacturing**	**(08 Hrs.)**
Introduction to Additive Manufacturing (AM): Need for Additive Manufacturing, Generic AM process, Distinction between AM and CNC, Classification of AM Processes, Steps in AM process, Advantages of AM, Major Applications. **Vat Photo polymerization AM Processes:** Stereo lithography (SL), Materials, SL resin curing process, Micro-stereo lithography, Process Benefits and Drawbacks, Applications of Photo polymerization Processes. **Extrusion-Based AM Processes:** Fused Deposition Modelling (FDM), Principles, Materials, and Plotting and path control, Bio-Extrusion, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes.		
Unit IV	**Group Technology and FMS**	**(08 Hrs.)**
Group Technology: Part families, Part Classification and coding, Cellular manufacturing, and composite part concept. Concept of manufacturing systems and automation, automation strategies, concept of machine cell and CMS, Building blocks of FMS Planning and implementations of FMS.		
Unit V	**Computer Aided Process Planning**	**(08 Hrs.)**
Process Planning and Production Planning, manual experience-based planning, Decision table and decision trees, Process capability analysis, Variant and Generative process planning approach, Process planning systems like CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP. Introduction to total integrated process planning systems.		
Unit VI	**Robots in Manufacturing**	**(08 Hrs.)**
Application of Robots in continuous arc welding, spot welding, spray painting, assembly operation, cleaning, robot for underwater applications. Robotics and Automation for Industry 4.0, Applications in unmanned systems, defense, medical, industries, Co-bot etc. Robots for Inspection: Robotic vision systems, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection, software considerations.		

Term Work

1. Study and demonstration of EDM Machine.
2. Study and demonstration of ECM Machine.
3. Manual part programming using G and M codes for Turning, Step turning, Taper turning, Facing.
4. Manual part programming using G and M codes for Drilling.
5. Component to be manufactured on CNC machine.
6. CNC Milling program involving linear motion and circular interpolation.
7. A study on group technology method utilized in FMS
8. Measurements of geometric parameters of parts using Coordinate Measuring Machine (CMM).
9. Manufacturing of Component using Additive manufacturing Technique.
10. Study of application of robot in manufacturing

11. Generating G and M code using Delcam and Mastercam
12. Simulation of Tool using Delcam and Mastercam

Text Books:

1. P. C. Sharma, Production Engineering, S. Chand Publications
2. R. K. Jain, Production Technology, Khanna Publishers
3. P.Radhakrishnan,V.Raju, CAD/CAM/CIM, New Edge international Publishers.

Reference Book

1. P. N. Rao, Manufacturing Technology- Vol 1, McGraw Hill Education (India) Private Limited
2. P. N. Rao, Manufacturing Technologyp, Vol- II, McGraw Hill Education (India) Private Limited
3. B. S. Raghuwanshi, Workshop Technology, Vol-II, Dhanpat Rai & Co.
4. E. P. DeGrmo, J. T. Black and A. Kosher, Material and processes in manufacturing, PHI
5. HMT Handbook, Production Technology, TMH
6. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", 2ndEdition, Springer, 2015.
7. PatriK. Venuvinod and Weiyin Ma, "Rapid Prototyping: Laser-based and Other Technologies", Springer, 2004.
8. S. R. Deb. "Robotics", Tata McGrawHill Publishing Co. Ltd., ISBN 0-07-460090-
9. M. P. Grover, M. Weiss, R. N. Nagel, N. G. Odrey, "Industrial Robotics Technology",ISBN 0-07-100442-
10. Computer Integrated Manufacturing and Engineering- U.Rembold, Addison Wesley Publishers, 1993 edition.
11. Quick Responsive Manufacturing – Rajan Suri, Productivity Press, 1998.
12. Principles of computer integrated manufacturing- S, Kant Vajpayee, PHI Learning Private Limited, New Delhi, 2012.

Project Based Learning:

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. Design a model for Electro discharge machining
2. Design a model for Electro chemical machining
3. Select a Industrial drawing, and prepare CNC program and implement it on CNC
4. Make a Prototype Model for Tool changer for CNC
5. Make a Prototype Model for Clamping and decamping of job CNC
6. Design and fabrication of CNC Machine using Arduino
7. Design and manufacturing a Fixture for an Industrial component.
8. Design and manufacturing a Jig for an Industrial component.
9. Working model of 3D Printer
10. Experimental Investigation of Machining Parameter for EDM Using Various Electrode
11. Manufacturing of a pick and place robot model.
12. Robot applications in unmanned systems, defense, medical, industries
13. Prepare a process plan for Industrial component
14. Case study on Group Technology.

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

ELECTRICAL CONTROL SYSTEMS

(Course No.)

Designation of Course	**Electrical Control Systems**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	-- Marks	
	Total	**125 Marks**	**04**

Course Prerequisite:-	The student should have basic knowledge of 1. Engineering mathematics, Laplace Transform, Test signals, differential equation solution
Course Objective:-	To provide knowledge about 1. Construct a working mathematical model of a system, outline and develop transfer function models according to the design specification for physical system analysis. 2. Make use of time-domain and frequency-domain analyses of the model to evaluate the system's behavior. 3. Model the state variable representation of physical systems and illustrate the effect of state feedback. 4. Design PID controllers.
Course Outcomes:-	On completion of the course, students will be able to 1. Determine and use models of physical systems in forms suitable for use in the analysis and design of control systems. 2. Analyze the system from the transfer function. 3. Understand the time domain behavior of first and second order systems 4. Utilize controllers such as PID and Lead-Lag for control design. 5. Apply various control systems concepts to analyze and find the stability of control systems. 6. Express and solve system equations in state variable form, analyze the observability of the system in state modelling.

Course Content

UNIT I	**Introduction to control system in electrical**	**(06 Hrs.)**
Block diagram of control system, in electrical industrial applications of control system, open loop and closed loop control, fundamentals of feedback control system, Block diagram reduction Techniques, Signal flow graph, Mason's gain formula. Mathematical Model of translational Robot System		
UNIT II	**Modelling of electrical systems**	**(06 Hrs.)**
Translational and rotational electrical systems, Analogy for mechanical and electrical systems, Potentiometer, Synchros, AC- DC Servomotor, Stepper motor, Gear Trains, AC-DC servomechanism, Tacho-generator, optical encoder.		
UNIT III	**Time Domain Analysis**	**(06 Hrs.)**
Transient response, steady state response, Types of test signals, S-planeMeasures of performance of the standard first order and second order system, Time domain specifications, Types of test inputs, Steady state error, error constants, generalized error coefficient.		

UNIT IV	Frequency Domain Analysis	(06 Hrs.)
Stability- concept and definition, Poles, Zeros, Order and Type of systems, Routh-Hurwitz test, Root locus technique, bode plot, Nyquist plot, Phase Margine and Gain Margin, Nyquist stability criterion robustness, Stability analysis in frequency domain.		
UNIT V	**Controller and Compensator Design**	**(06 Hrs.)**
Introduction to Compensator, Need of compensation, Introduction to PID controller: P, PI, PD and PID Tuning concept of Zeigler-Nicholas method, transfer function of lead, lag, lag- lead, lead and lag compensator design using root locus, Use of SISO design tool in MATLAB.		
UNIT VI	**State Space Analysis for Electrical system**	**(06 Hrs.)**
Concept of state and state variable, modelling of systems using state variables, Coordinate transformations and canonical realizations, Solution of state variables, Controllability and observability.		

Term Work

The term work shall consist of record of minimum eight experiments. Four from first seven, four from next seven and to ensure at least one experiment on each unit.

1. To plot characteristics of potentiometer and observe potentiometer pair as an error detector.
2. To determine transfer function of DC servomotor.
3. To plot characteristics of Synchro and observe Synchro pair as an error detector.
4. To plot and analyses the time response behavior of second order system.
5. To observe step response of RLC series circuit for different values of R.
6. To plot root locus using MATLAB and determine value of K for given value of damping ratio from the plot. ii) To analyze effect of addition of zero/ pole on root locus
7. To observe frequency response and to draw bode plot of lag, lead network.
8. To analyze stability of system in frequency domain by i) Nyquist plot ii) Bode plot using MATLAB.
9. To calculate steady state error for different inputs and different types of system (MATLAB).
10. To simulate and determine the effect of P, PD, PI, PID Controller on a second order systems.
11. To tune PIDcontroller and analyze step response of temperature/ pressurecontrolsystem.
12. To design lead compensator in MATLAB/Simulink using bode plot and observe step response of uncompensated and compensated system.
13. To design lag compensator in MATLAB/Simulink using root locus technique and observe step response of uncompensated and compensated system.
14. State space model for classical transfer function using MATLAB -Verification.

Project Based Learning

1. Design and develop a temperature controller using PID.
2. Develop a closed loop Simulink model of dc motor draw and the bode plot.
3. Simulate and obtain the step response of second order control system.
4. Formulate the state space model for a classical transfer function and examine its stability in MATLAB/Simulink.
5. Perform the stability analysis of DC motor.
6. Design a stepper motor control.
7. Design a BLDC motor control.

Text Books

1. N. J. Nagrath and M.Gopal, “Control System Engineering”, New Age International Publishers, 5th Edition, 2009.

2. Ogata K., Modern Control Engineering, Prentice-Hall of India Pvt Ltd., New Delhi, 3rd edition, 2000.
3. Norman S. Nise, Control Systems Engineering, 2014, 7th Edition, John Wiley & Sons, New Jersey, USA
4. M.N.Bandopadhyay, “Control Engineering Theory and practice”- Prentice Hall of India 2006.

Reference Books

1. Schaum’s Outline Series, “Feedback and Control Systems” Tata McGraw-Hill, 2007.
2. M. Gopal, “Control System – Principles and Design”, Tata McGraw Hill, 4th Edition, 2012.
3. D. Roy Choudhary, "Modern Control Engineering", PHI Learning Pvt. Ltd., 2005

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

INTRODUCTION TO FINITE ELEMENT ANALYSIS

(Course No.)

Designation of Course	**Electrical Control Systems**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**05**

Course Prerequisites:-	Basics knowledge of: 1. Engineering Mathematics 2. Engineering Mechanics 3. Strength of Materials 4. Numerical methods
Course Objectives: -	To provide the knowledge of 1. Analyze a physical problem. 2. Develop finite element procedures for accurately investigating the problem, and effectively perform and document findings. 3. Solve 1 D, 2 D and dynamic problems using Finite Element Analysis approach.
Course Outcomes: -	Students should be able to 1. Remember the basic concepts of Solid mechanics and understand the concepts of Nodes and elements. 2. Understand the Formulation of Element Stiffness Matrix and Load Vector and apply it for 1D elements. 3. Understand the Formulation of Element Stiffness Matrix and Load Vector and apply it for 2D elements 4. Understand the concept of Isoperimetric elements and element quality criteria. 5. Understand the concept of 1D Steady State Heat Transfer and apply it solve heat transfer problem. 6. Understand the concept free vibration and evaluate the Eigenvalues and Eigen vectors for stepped bar and beam.

Course Contents

Unit I	**Introduction to FEA**	**(08 Hrs.)**
Introduction to FEM, Stress strain relations, shape functions- linear and quadratic, Triangular, Quadrilateral, Higher order elements, Variational methods of approximation-Rayleigh Ritz Method, Methods of Weighted Residuals-Least Square Method, Subdomain Method, Collocation Method, Garlekin's method.		
Unit II	**One Dimensional Problems**	**(08 Hrs.)**
Finite element modeling, Convergence of results, Potential energy approach, Global stiffness matrix, properties of stiffness matrix, load vector, Penalty approach, Elimination approach, Finite Element Analysis of 2-D truss structure and Constant strain triangle.		
Unit III	**Two Dimensional Problems**	**(08 Hrs.)**
Plain Stress, Plain Strain, Types of 2D elements, Formulation of elemental stiffness matrix, and load vector for truss element, Formulation of elemental stiffness matrix and load vector for CST element.		

Unit IV	Isoperimetric Elements	(08 Hrs.)
Isoperimetric formulation – Natural Co-ordinate system, Lagrangian interpolation polynomials, Isoperimetric element, Numerical Integration Newton Cotes formula, Gauss Quadrature formula in two and three dimensions, triangular elements, rectangular elements. Dynamic Analysis, Formulation of Dynamic problems, Consistent and Lumped Mass Matrices. Solution of Eigen Value Problems. Transformation Method, Jacobi Method, Vector Iteration Method, Subspace Iteration Method.		
Unit V	**1D Steady State Heat transfer**	**(08 Hrs.)**
Governing Differential Equation; Steady State Heat Transfer Formulation of 1 D Element for Conduction and Convection; Boundary Conditions and Solving for Temperature Distribution; 1D Heat Transfer Steps involved in Processing Steps.		
Unit VI	**Dynamic Analysis**	**(08 Hrs.)**
Lumped mass and Consistent Mass Matrices; Free Vibration Problems, Formulation of Eigen Value and Eigen Vector Problem by Power Method, Step wise solution of Problems on Vibration in Bar Element; FEM Formulation. Time dependent Problems.		

Term Work

Term work shall consist of

1. Four computer program assignments to be developed for FEA. (Using any programming language.)
2. Two assignments on structural Analysis using FEA Software
3. Two assignments on modal Analysis using FEA Software

Textbooks/ Reference Books

1. K. J. Bathe, “Finite Element Procedures”, PHI
2. R. D. Cook, D. S. Malus, M. E. Plesha, “Concepts and Applications of Finite Element Method Analysis”, John Wiley
3. J. N. Reddy, “An introduction to Finite Element Method Analysis”, MGH
4. Desai & Abel, “Introduction to Finite Element Methods”
5. D. L. Logan, “A course in the Finite Element Method”, Third Edition, Thomson Learning
6. T. R. Chandrupatia, A. D. Belegundu, “Introduction to Finite Elements in Engineering”, Third Edition, PHI
7. John D. Anderson, “Computational Fluid Dynamics: The Basics with Applications”, McGraw Hill, 1995

Project Based Learning

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. Structural analysis of any mechanical component.
2. Thermal analysis of any mechanical component.
3. Modal analysis of any mechanical component.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

VOCATIONAL COURSE –III MOUNTING AND COMMUNICATION OF SENSORS
(Course No.)

Designation of Course	**Vocational Course –III Mounting and Communication of sensor**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- -- Hours/ Week	End Semester Examination	-- Marks	--
Tutorial:- --Hours/ Week	Internal Assessment	-- Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**50 Marks**	**01**

Course Prerequisite:--	Basics knowledge of: 1. Sensor, Location principle, Mounting accessories
Course Objective:-	To provide Knowledge about 1. Sensor Mounting and location principle 2. Sensor calibration methods 3. Communication and networking of sensors
Course Outcomes:-	On completion of the course, students will be able to 1. Identify different sensor Mounting and accessories 2. Understand calibration methods of sensor 3. Examine sensor mounting through site visit. 4. Understand Communication techniques of sensor 5. Examine sensor communication techniques through site visit 6. Identify Sensors in HMI

Course Content

Unit I	**Introduction to Sensor Mounting and Location Principle**	**(04 Hrs.)**
Introduction to sensor mounting, different type of sensor mounting, Mounting procedure of different type of robotics sensor (tactile, proximity, pressure, force, velocity, vision sensor etc.)		
Unit II	**Calibration Methods of Sensors**	**(04 Hrs.)**
Introduction to sensor calibration, need of calibration, different types of sensor calibration methods, Measurement characteristic of sensor, Calibration example on real time robotics system such as calibration of proximity sensor for detection of object by robot end effector		
Unit III	**Case Studies on Sensor Mounting and Location**	**(04 Hrs.)**
Students are required to visit any relevant industry or identify lab set up in department and prepare a case study report covering sensor mounting and location principle for the same		
Unit IV	**Communication techniques of sensor**	**(04 Hrs.)**
Communication and networking of sensors, control of manufacturing process, tracking- the meantime between operations interventions, tracking the yield and mean process time, detection of machining faults, diagnostic systems, resonance vibration analyzer, sensing motor current for signature analysis, temperature sensing.		
Unit V	**Case Studies of Sensor Communication**	**(04 Hrs.)**
Students are required to visit any relevant industry or identify lab set up in department and prepare a case study report covering sensor mounting and location principle for the same		
Unit VI	**Sensor Interfacing in HMI**	**(04 Hrs.)**
Introduction to sensor interfacing in HMI, different methodologies of sensor interfacing in HMI, IoT devices for sensor interfacing in HMI, Sensor interfacing in HMI application such as ATM , field and service robot.		

Term Work

Term work shall consist of

1. Demonstartion of tactile sensor for mounting of robot manipulator
2. Demonstration of vision sensor for mounting of robot manipulator
3. Study of location principle for sensor on robot body
4. Calibration of pressure/force sensor
5. Demonstration of sensor networking for any application like health monitoring, Engine management system, processing plant etc.
6. Study of different techniques for Human machine interfacing technique
7. Case study on Sensor location and mounting based on industrial visit/training
8. Case study on Sensors communication and networking based on industrial visit/ training.

Reference Book:-

1. Horst Ezichos, Measurement, Testing and Sensor Technology, springer publication
2. Clarence W. de Silva ,Sensor System Fundamentals and application Taylor and Francis

B. Tech. (Robotics & Automation)
Sem.-VI

ELECTRO HYDRAULICS AND PNEUMATICS

(Course No.)

Designation of Course	**Electro Hydraulics and Pneumatics**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**05**

Course Prerequisites:	1. Hydraulics and Pneumatics: Principles 2. Basic Electrical Engineering.
Course Objectives: -	To provide knowledge about 1. Components of electro pneumatic and electrohydraulic system 2. PID Control of Fluid Power System 3. Design and selection of fluid power system
Course Outcomes: -	The students should be able to 1. To Identify Components of electro pneumatic and electrohydraulic system 2. To Develop electro pneumatic and electrohydraulic system 3. To Develop IoT based circuit in Fluid power system 4. To Develop electro pneumatic circuit consist of Logic valves 5. To Design and select Fluid Power system components 2. 6.To Examine Trouble shooting of fluid power system

Course Contents

Unit I	**Introduction to Electro-Hydraulics and Electro-Pneumatics Systems**	**(08 Hrs.)**
Advantages of electro-hydraulic/electro-pneumatic systems, Fields of application of electro-hydraulic/electro-pneumatic systems, Symbols in electro-hydraulic/electro-pneumatic systems, types of solenoid valves, proximity sensors, Different switches: -Relays, Reed, temperature, pressure, flow, level transmitter, Timers, Counters.		
Unit II	**Advanced electrical controls for fluid power systems**	**(08 Hrs.)**
Use of PID Controller and PLC, Proportional Direction Control Valve, Electro-hydraulic Servo System, Components of electro-hydraulic Servo System, PID tuning, PLC logic for various hydraulic and pneumatic circuits. Development of hydraulic and pneumatic circuits using PLC. Fluid Logic Control Systems-AND, OR, NAND, NOR, Exclusive-OR		
Unit-III	**Electro-Hydraulic Circuits**	**(08 Hrs.)**
Development of Electro-hydraulic Circuits: Reciprocating, regenerative, speed control (meter in, meter out and bleed off), sequencing, synchronization, automatic reciprocating, IOT Applications.		
Unit IV	**Electro-Pneumatic Circuits**	**(08 Hrs.)**
Development of Electro-hydraulic Circuits: Automatic reciprocating circuit, Speed control circuit, Pneumatic circuit involving Shuttle valve/ Quick exhaust valve / Two pressure valve, IOT Applications		
Unit V	**Fluid Power System Design and Analysis**	**(08 Hrs.)**
Calculation of piston velocity, thrust under static and dynamic applications, considering friction, inertia loads, design considerations for cylinders, Design of hydraulic/pneumatic circuits for practical application, selection of different components such as reservoir, control elements,		

actuators, accumulator, intensifier, filters, pumps. (Students are advised to refer manufacturers' catalogues for design and use simulation tool like Automation Studio for analysis). Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools		
Unit VI	**Maintenance and Troubleshooting of Fluid power systems and applications**	**(08 Hrs.)**
Maintenance need, Common Problems, maintenance schedule, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, flow resistance, seal failures, maintenance of air compressor,		

Term Work:

Term work shall consist record of minimum 8 experiments from the following.

1. Design of electro-hydraulic circuits
2. Design of electro-pneumatic circuits
3. Control of fluid power systems using PLC
4. Following experiments to be done on electro-hydraulic trainer
   a) Regenerative circuit b) Speed control circuit
   c) Sequencing circuit d) Traverse and feed circuit etc.
5. Following experiments to be done on electro- pneumatic trainer
   a) Automatic reciprocating circuit b) Speed control circuit
   b) Pneumatic circuit involving Shuttle valve/ Quick exhaust valve / Two pressure valve
6. Design of simple electro-hydraulic/electro-pneumatic systems used in practice such as hydraulic clamp, jacks, dumper, forklift etc by using fluid simulation software's such as LVSIM®-HYD & PNEU, AUTOMATION STUDIO.
7. Industrial visit to study Electro-Hydraulic / Electro-Pneumatic based Automation systems.
8. Operation and troubleshooting of fluid power systems
9. Study of IOT Based electro-hydraulic/electro-pneumatic systems

Project Based Learning: -

1. To prepare a model of involving application of electrohydraulic circuit
2. To prepare a model of involving application of electropneumatic circuit
3. To prepare cylinder sequencing simulation circuit in Automation Studio
4. To prepare cylinder synchronization simulation circuit in Automation Studio
5. To prepare model of automatic hydraulic jack
6. To prepare model of automatic hydraulic lift/stacker

Text Books:

1. Esposito A, Fluid Power with application, Prentice Hall
2. Majumdar S.R, Oil Hydraulic system- Principle and maintenance, Tata McGraw Hill
3. Majumdar S.R, Pneumatics Systems Principles and Maintenance, Tata McGraw Hill
4. Stewart H. L, Hydraulics and Pneumatics, Taraporewala Publication

References Books:

1. Pipenger J.J, Industrial Hydraulics, McGraw Hill
2. Pinches, Industrial Fluid Power, Prentice Hall
3. Yeaple, Fluid Power Design Handbook
4. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science and Technology Books
5. ISO - 1219, Fluid Systems and components, Graphic Symbols
6. Standard Manufacturer's Catalogues

Unit Test

Unit Test- I	Unit I,II,III
Unit Test- II	Unit IV,V,VI

ROBOTIC SIMULATION

(Course No.)

Designation of Course	**Robotic Simulation**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	-- Marks	
	Total	**125 Marks**	**04**

Course Prerequisite:-	1. Engineering mathematics, Differential Equation, Transfer Function 2. Modelling and design of Mechanism, Mechanical system
Course Objective:-	To provide Knowledge about 1. Different types of Modelling strategies 2. Optimization and design of system techniques 3. Different types of simulation software
Course Outcomes:-	On completion of the course, students will be able to 1. To Define Different type of Modelling strategies 2. To Develop Mathematical Model by using different modelling technique 3. To Design and optimize the system 4. To Design Fuzzy Model 5. To Simulate Model by different simulation software

Course Content

Unit I	**Introduction to Modelling strategy**	**(06 Hrs.)**
System, environment, input and output variables, State variables; Static and Dynamic systems; Hierarchy of knowledge about a system and Modeling Strategy. Introduction of Physical Modeling: Dimensions analysis, Dimensionless grouping of input and output variables of find empirical relations, similarity criteria and their application to physical models, Simplification techniques of physical models.		
Unit II	**Modelling of System with Known Structure**	**(06 Hrs.)**
Deterministic model-(a) distributed parameter models in terms of partial identification and their solutions and (b) lumped parameter models in terms of differential and difference equations, state space model, transfer functions block diagram and sub systems, stability of transfer functions, modelling for control		
Unit III	**Modeling Based on Expert Knowledge**	**(06 Hrs.)**
Fuzzy sets, Membership functions, Fuzzy Inference systems, Expert Knowledge and Fuzzy Models, Design of Fuzzy Controllers. Testing of Fuzzy controller.		
Unit IV	**System Simulation**	**(06 Hrs.)**
Basics of simulation, Steps in simulation, Discrete event system simulation, Advantages and disadvantages of simulation, Decision making with simulation. Techniques of simulation, Monte Carlo method, Experimental nature of simulation, Distributed lag models, Cobweb models Continuous system models, Analog and Hybrid simulation, Feedback systems, Computers in simulation studies.		
Unit V	**Simulation Software**	**(06 Hrs.)**
Comparison of simulation packages with programming languages, classification of simulation software, Description of a general-purpose simulation package, Design of scenario and modules,		

dialog box, database, animation, plots and output, interfacing with other software, summary of results. Examples with MATLAB SiMULINK/ AWESIM / ARENA/LAB VIEW/SIEMENS NX MCD/ ROBO Analyser.		
Unit VI	**Optimizations and Design of Systems**	**(06 Hrs.)**
Summary of gradient-based techniques: Nontraditional Optimizations techniques genetic Algorithm (GA)- coding, GA operations elitism, Modified GA, Application using MATLAB: Simulated Annealing.		

Term work-

1. Build and Simulate Cartesian Configuration type of Robot for any application
2. Build and Simulate Cylindrical Configuration type of Robot for any application
3. Build and Simulate Spherical Configuration type of Robot for any application
4. Build and Simulate SCARA Configuration type of Robot for any application
5. Build and Simulate Kinematic joints in 2 link manipulators
6. Build and Simulate Kinematic joints in 3 link manipulators
7. Build and Simulate Robot Manipulator for Assembly operation in Smart Factory “
8. Industrial Visit to any automation industry using Robot Simulation Software

Project Based Learning

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. Modal analysis of any robotics end effector.
2. Development of any automation model based on Monte Carlo method
3. Prepare a system simulation Model for Pick and Place Robot application
4. Prepare a system simulation Model for Robot welding application
5. Prepare a system simulation Model for Robot in assembly application
6. Prepare a system simulation Model for Robot vision application/ Inspection / sorting Application

Text Book

1. Shannon, R. E., “System Simulation: the Art and Science”, Prentice Hall Inc. 1990
2. Pratab. R " Getting started with MATLAB" Oxford university Press 2009

Reference Book

1. Zeigler B.P. Praehofer. H. and Kim I.G. "Theory of modeling and simulation", 2 nd Edition. Academic press, 2000
2. Ogata K , “Modern control Engineering" 3 rd edition. Prentice hall of India 2001
3. Jang J.S.R. sun C.T and MizutaniE,, "Neuro-Fuzzy and soft Computing ", 3 rd edition, Prentice hall of India, 2002

Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

INSTRUMENTATION FOR ROBOTICS AND AUTOMATION
(Course No.)

Designation of Course	**Instrumentation for Robotics and Automation**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**05**

Course Prerequisite:-	1. Knowledge of basic control strategies, Knowledge of working of basic controllers
Course Objective:-	To provide Knowledge about 1. Classification by coordinate system and control system 2. Acquire Knowledge on Different types of Power Sources and Sensors 3. Classification of Manipulators, Actuators and Grippers 4. Acquire Knowledge of kinematics and Applications of different Robots
Course Outcomes:-	On completion of the course, students will be able to 1. Acquire knowledge on different types of Power Sources (actuators) and Sensors, 2. Classification of Manipulators, Actuators and Grippers Acquire knowledge on different applications of various types of robots. 3. Analyze the direct and the inverse kinematic problems and calculate the manipulator dynamics 4. Able to identify the applications of robots in different process operations.

Course Content

Unit I	**Basic Concepts & Power Sources**	**(08 Hrs.)**
Fundamentals: Robot Components, An overview of Robotics power sources, Types of robot power sources, comparison of different robot power sources, Interfacing and communication module between power sources and robot.		
Unit II	**Smart Sensors**	**(08 Hrs.)**
Intelligent Sensors: General Structure of smart sensors & its components, Characteristic of smart sensors: Lidar 2D- 3D Lidar Sensor, Self-calibration, Self-testing & self-communicating, Application of smart sensors: Automatic robot control & automobile engine control.		
Unit III	**Design of Robotics Manipulators and Grippers**	**(08 Hrs.)**
Introduction: Robot manipulator , Classification, Design Procedure of Mechanical Grippers, Gripper force Analysis and Gripper Design, Design of Vacuum Grippers, Active and passive Grippers. Selection criteria for Robotics Grippers		
Unit IV	**Robotics Vision Techniques**	**(08 Hrs.)**
Robot Vision devices: Camera, CCD, Image acquisition, Illumination Techniques, Imaging Geometry, Some Basic Relationships between Pixels, Segmentation, Description, Segmentation and Description of 3-D Structures, Recognition, Interpretation. Advanced vision technique. Algorithm to capture dynamics System		
Unit V	**Robotic controllers and accessories**	**(08 Hrs.)**

Microprocessors and Microcontrollers based robotic controllers, Peripheral Interfacing with microcontrollers and its programming in C, Arduino platform as robotic controller, Sensors & Actuators, Gripper's interfacing with robotic controller, Industrial Robot Controller, Selection criteria for selection of controller		
Unit VI	**Robot Operating Systems**	**(08 Hrs.)**
Introduction –The ROS Equation, Role and responsibilities of ROS, History, Distributions & difference from other meta-operating systems. Version of ROS, ROS framework: Operating system and its various releases.		

List of Practical /Term work: -

1. Study of different types of power sources required for automation
2. Study and Characteristic of different actuator of robots
2. Demonstration of Smart sensor used in sensor lab.
1. Study of Robot Vision Techniques
3. Demonstration of microcontroller kit for any robotic application
4. Demonstration of Arduino kit/pic controller/PLC for any robotic application
5. Study and comparison of different robot operating system /Explore RoS for Industrial Application. /Develop Motor Simulation through RoS
6. Industrial Visit to any robotic component manufacturing industry.

Project Based Learning

1. Develop a robotics model by using rechargeable power sources
2. Develop a robotic model consisting of different electrical actuator
3. Develop a robotic model consisting of different hydraulic and pneumatic actuator
4. Develop a robot working on speech sensor
5. Develop a robot for inspection /surveillance application

Text Book

1. Mikell. P, Weiss. G. M, Nage. l R. N and Odraj .N.G, ‖Industrial Robotics", McGraw Hill Singapore, 1996.
2. Ghosh, ‖Control in Robotics and Automation: Sensor Based Integration", Allied Publishers, Chennai, 1998. R18 B.Tech.
3. Industrial Automation and Robotics, A. K. Gupta and S. K. Arora, University Science Press
4. Robotics and Industrial Automation, R. K. Rajput, S. Chand, New Delhi
5. Automation and Robotics, Khushdeep Goyal, Deepak Bhandari, S. K. Kataria& sons
2. Robotics and Controls, R. K. Mittal & I. J. Nagarath, Tata McGraw Hill
3. 7.Magnetic Gripper for Unstructured Robotic Workspace by Lambart Academic Publication

Reference Book: -

1. Deb. S.R, ‖Robotics technology and flexible Automation", John Wiley, USA 1992.
2. Asfahl. C.R, ―Robots and manufacturing Automation", John Wiley, USA 1992.
2. Klafter. R. D, Chimielewski. T. A, Negin. M, ―Robotic Engineering – An integrated approach", Prentice Hall of India, New Delhi, 1994.

Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

QUANTITATIVE TECHNIQUE, COMMUNICATION & VALUES
(Course No.)

Designation of Course	**Quantitative Technique, Communication & Values**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- -- Hours/ Week	Term Work	-- Marks	--
	Oral/Practical	-- Marks	
	Total	**100 Marks**	**04**

Course Prerequisite:-	The students should have knowledge of 1. Basic math's and reasoning, and comprehensive ability 2. Basic knowledge of communication process, soft skills 3. Basic knowledge and idea about leaders and leadership qualities, ethics, etiquettes and values
Course Objective:-	To provide Knowledge about 1. The Quantitative Techniques, Communication and Values aims to augment students to face the campus recruitment test and train them on applying short techniques/ tricks to solve questions of Maths, reasoning and English in very less amount of time. The communication and values section focuses on the aspects of communication and soft skills such as grooming personality for leading team, presentation, business communication which would enable graduates to project themselves as a professional in the corporate sector and/or otherwise.
Course Outcomes:-	On completion of the course, students will be able to 1. Solve the aptitude test in the recruitment and competitive exam by applying short techniques and solve the question in less amount of time 2. Apply the short mnemonics and techniques to solve the questions of logical reasoning in the placement and competitive exam in lesser time. 3. Develop the verbal ability to communicate effectively using suitable vocabulary and proper sentence pattern 4. Understand the concept of soft skills and its implication at workplace 5. Build up the ability to study employment business correspondences and its proper implications 6. Understand business ethics, etiquettes and values and apply them in the professional ventures.

Course Content

Unit I	**Quantitative Aptitude**	**(08 Hrs.)**
Number system, Percentage, profit and loss, Simple Interest and Compound Interest, Ratio, Proportion and Average, Mixture and Allegation, Time, Speed & Distance, Time &Work , Permutation & Combination, Probability, Pipes and Cisterns		
Unit II	**Non-Verbal Reasoning**	**(08 Hrs.)**
Coding, Decoding, Number series, Blood relation Directions, cubes &dices, Data Interpretation, Data Sufficiency, Set Theory & Syllogisms, Matching, Selection & Arrangement, Clocks & Calendars, Visual Reasoning, Input, Output & Flow Chart		
Unit III	**Verbal Reasoning**	**(08 Hrs.)**

Sentence Patterns, Sentence correction and spotting errors, Vocabulary, antonyms and synonyms and analogy, Phrasal Verbs, idiomatic expressions, reading comprehension, closest, sentence rearrangement and theme detection		
Unit IV	**Self-Awareness and Soft Skills Development**	**(08 Hrs.)**
Concept of SWOT, Importance of SWOT, Individual & Organizational SWOT Analysis, Soft skills, meaning, need and importance, difference between soft skills and hard skills, life skills and personal skills, Leadership skills,-Importance ,Types, Attributes of good leader Motivational theories and leadership ,Emotional intelligence in personal and professional lives its importance need and application, Team Building and conflict resolution Skills ,Problem solving skills, Time Management and Stress Management Skills Pareto Principle(80/20) Rule in time management, Time management matrix, creativity and result orientation, working under pressure, stress management		
Unit V	**Communication and Honing Employment Skills**	**(08 Hrs.)**
Communication process, Non-verbal codes in communication, importance of LSRW in communication, Barriers to communication, Principles of effective Technical writing, Email writing and Netiquettes, **Letter writing** – formal letters, job application letter, cover letter, structure of technical report writing, Building Resume and CV, Tips to build an effective Resume Group discussion, Skills required for Group Discussion Interview skills, Ways of handling telephonic interviews, Importance of body language, grooming &etiquettes for getting right impression in PI&GD , Extempore, Introduction to PowerPoint presentation, ,Structure & flow of presentation,		
Unit VI	**Business Ethics, Etiquettes and Values**	**(08 Hrs.)**
The Importance of Ethics and Values in Business World, Respect for Individuality and diversity at workplace values of a good manager Key features of corporate etiquette, corporate grooming & dressing, etiquettes in social & office Setting-Understand the importance of professional behavior at the workplace, Corporate social responsibility (CSR) its importance and need.		

Project Based Learning

1. Prepare mock Tests on Unit –I and solve it in given time(use of PSD lab manual)
2. Prepare mock Tests on Unit –I and solve it in given time(use of PSD lab manual)
3. Prepare online model test based on Unit-II and solve it in specific time(use of PSD lab manual)
4. Prepare online model test based on Unit-II and solve it in specific time(use of PSD lab manual)
5. Form a model for spoken and written communication skills which avoid grammar mistakes and common errors
6. Develop various activity models for enriching and developing vocabulary
7. Preparing strategies by using SWOT and TWOS analysis
8. Analyzing differences between Soft Skills, Hard skills, and Personal skills
9. Develop Bruce Tuchman's Team Building Models with classmates/Teammates
10. To study different personalities of Leaders from various sectors and find out their attributes and success stories
11. Preparing a model for Time Management Skills and Stress Management and conduct activities for effective implementation of it.
12. Form a model to develop LSRW and communication Skills
13. Conduct mock interview and practice GD activities to build competencies for actual selection process
14. Preparing a model for evaluating Values and Ethics of Good Managers
15. Preparing a model of dress codes and attire for different professional situations corporate etiquettes and its implications
16. Develop some good activities to understand the importance and need of Corporate social

responsibility (CSR)

Reference Books

1. Quantitative Aptitude by R. S. Agarwal published by S. Chand
2. The Book of Numbers by Shakuntala Devi
3. A Modern Approach To Logical Reasoning by R. S. Agarwal published by S. Chand
4. A New Approach to Reasoning Verbal & Non-Verbal by InduSijwali
5. Business Communication by Meenakshi Raman, Prakash Singh published by Oxford University press, second edition
6. Communication Skills by Sanjay Kumar, Pushp Lata, published by Oxford University press, second edition
7. Technical Communication by Meenakshi Raman, Sangeeta Sharma published by Oxford University press
8. Developing Communication Skills by Krishna Mohan, Meera Banerji published by Macmillan India Pvt Ltd
9. Soft Skills by Meenkashi Raman, published by Cengage publishers
10. Soft Skills by Dr. K Alex published by Oxford University press
11. Soft skills for Managers by Dr. T. KalyanaChakravarthi and Dr. T. LathaChakravarthi published by biztantra

Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

ARTIFICIAL INTELLIGENCE AND NEURAL NETWORK FOR ROBOTS
(Course No.)

Designation of Course	**Artificial Intelligence and Neural Network for Robots**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial:- 01 Hours/ Week	Internal Assessment	40 Marks	
Practical:- -- Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	-- Marks	
	Total	**125 Marks**	**04**

Course Prerequisite:-	1. Engineering mathematics-III, Statistics and Numerical Methods, Sensors Technology
Course Objective:-	To provide Knowledge about 1. To understand the artificial intelligence algorithms to robotics problems. 2. To understand the performance of AI algorithms 3. To compute the complex problems in flexible automation
Course Outcomes:-	On completion of the course, students will be able to 1. Use different machine learning techniques 2. Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation and learning 4. Demonstrate awareness and a fundamental understanding of AI techniques in intelligent agents, artificial neural networks 5. Demonstrate proficiency in developing applications in AI and Machine Learning. 1. Demonstrate an ability to share in discussions of AI, its current scope and limitations, and societal implications.

Course Content

Unit I	**Introduction to artificial intelligence techniques**	**(06 Hrs.)**
Goals of AI in manufacturing, tools for AI such as Search algorithm, Mathematical optimization, Evolutionary computation, fuzzy logic, Probabilistic methods for uncertain reasoning such as Bayesian network, Hidden Markov model, Kalman filter, Decision theory and Utility theory, statistical learning methods, support vector machines, neural networks, expert systems.		
Unit II	**Handling uncertainty and learning for Robotics system**	**(06 Hrs.)**
Non-monotonic reasoning, probabilistic reasoning, use of certainty factors, fuzzy logic, Concept of learning, learning automation, genetic algorithm, learning by inductions, neural network, Unsupervised learning- K-Means clustering, Boltzmann machine, Supervised learning- classification algorithms, support vector machine.		
Unit III	**Search algorithms in AI**	**(06 Hrs.)**
Algorithms for uninformed and informed search, Heuristics search: hill climbing, branch and bound, best first search, Metaheuristics: Simulated annealing, Tabu search, ant colony optimization, real coded genetic algorithm. Cohort Intelligence		
Unit IV	**Machine vision in robotics**	**(06 Hrs.)**

Machine vision algorithms, Imaging based automatic sorting and inspection, image processing, imaging-based robot guidance.		
Unit V	**Intelligent robotic systems**	**(06 Hrs.)**
Recent Applications of intelligent systems for mobile Robot Motion Planning,Robot Surveillance, Path Planning Robot Control in Dynamic Environments, Task Based Hybrid Closure Grasping Optimization for Autonomous Robot Hand. Accurate Motion Control of Fast Mobile Robots, obstacle avoidance.		
Unit VI	**Artificial Neural Networks**	**(06 Hrs.)**
Artificial neurons, Networks of Artificial Neurons, Neural Learning, Supervised Learning, Unsupervised Learning, Fault Tolerance, Artificial Neural Nets and Statistics, ANN data selection, Evolutionary Design of Artificial Neural Networks: Evolving weights, network architecture, learning rules etc.		

Reference Book:-

1. Russell, Stuart and Norvig, Peter, Artificial Intelligence: A Modern Approach" Prentice Hall, 2003.
2. Aleksander, Igor and Burnett, Piers, Thinking Machines Oxford, 1987.
3. Bench-Capon, T. J. M., Knowledge Representation: An approach to artificial intelligence Academic Press, 1990.
4. Genesereth, Michael R. and Nilsson, Nils J, Logical Foundations of Artificial Intelligence Morgan Kaufmann,1987.
2. Michael Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems (3rd Edition)
3. Vinod Chandra S.S., Anand Hareendran S, " Artificial Intelligence And Machine Learning"
4. Luger " Artificial Intelligence", Edition 5, Pearson, 2008
5. Jacek M. Zurada, Introduction to Artificial Neural Systems, PWS Publishing Company, 1995.
6. Simon Haykin, Neural Networks: A Comprehensive Foundation, Macmillan College Publishing Company, 1994.
7. Mohamad H. Hassoun, Fundamentals of Artificial Neural Networks, The MIT Press, 1995.
8. Steger, Carsten, Markus Ulrich, Christian Wiedemann. Machine Vision Algorithms and Applications (2nd ed.). Wiley, 2018. ISBN 978-3-527-41365-2.
9. Mikell P Groover, Automation, Production System and Computer Integrated Manufacturing, Prentice Hall, Publications, 2016. ISBN 9789332549814
10. Bhattacharya S., Artificial Intelligence, Laxmi Publications, Ltd., 2008, ISBN: 9788131804896
11. Chopra Rajiv, Artificial Intelligence, S. Chand Publishing, 2012, ISBN9788121939485
12. Pawar P. J., Evolutionary Computations for Manufacturing, Studium Press, 2019, ISBN: 978-93-85046-52-0
13. Jain N, Artificial Intelligence: making a system intelligent, 2018, ISBN: 9788126579945

Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

VOCATIONAL COURSE IV (TROUBLESHOOTING AND MAINTENANCE OF ROBOTS)
(Course No.)

Designation of Course	**Vocational Course IV (Troubleshooting and Maintenance of Robots)**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- -- Hours/ Week	End Semester Examination	-- Marks	--
Tutorial:- -- Hours/ Week	Internal Assessment	-- Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**50 Marks**	**01**

Course Prerequisite:-	1. Different components of robots such sensor, actuator, controller
Course Objective:-	To provide Knowledge about 1. Trouble shooting procedure in automation 2. Maintenance method in automation
Course Outcomes:-	On completion of the course, students will be able to 1. Identify the fault in automation system 2. Identify the fault in service robotics system and Understand the maintenance procedure service robotics system 3. Identify the fault in field robotics system and Understand the maintenance procedure field robotics system 4. Identify the fault in PLC system Understand the maintenance procedure for PLC system 5. Identify the fault in manufacturing robots system Understand the maintenance procedure for manufacturing robotics system 6. Examine Trouble shooting and Maintenance procedure through field visit

Course Content

Unit I	**Introduction to Troubleshooting and Maintenance Methods in Automation**	**(04 Hrs.)**
Introduction Troubleshooting and Maintenance Methods in Automation, Benefits of maintenance in robotics system, Troubleshooting and Maintenance Methods of Automated CNC.		
Unit II	**Troubleshooting and Maintenance of Service Robots**	**(04 Hrs.)**
Troubleshooting and Maintenance of Service Robots for their different components such as actuator, sensor, power pack, controller, Maintenance plan for service robots		
Unit III	**Troubleshooting and Maintenance of Field Robots**	**(04 Hrs.)**
Troubleshooting and Maintenance of Field Robots for their different components such as actuator, sensor, power pack, controller, Maintenance plan for field robots		
Unit IV	**Troubleshooting and Maintenance of PLC**	**(04 Hrs.)**
Introduction to PLC system, Troubleshooting and Maintenance PLC system components.		
Unit V	**Troubleshooting and Maintenance Robots in Manufacturing**	**(04 Hrs.)**
Troubleshooting and Maintenance of manufacturing Robots for their different components such as actuator, sensor, power pack, controller, Maintenance plan for manufacturing robots		

Unit VI	Case Study Troubleshooting and Maintenance of Robot by Industrial Visit /Field visit/ Institute lab facility	(04 Hrs.)
Students are required to visit any relevant industry or identify lab set up in department and prepare a case study report covering sensor mounting and location principle for the same		

Term Work

Term work shall consist of

1. Study of Troubleshooting and maintenance methods for Industrial Robots
2. Demonstration of any robot manipulator which is under maintenance
3. Observation of Troubleshooting and maintenance procedure for service robots
4. Observation of Troubleshooting and maintenance procedure for field robots
5. Observation of Troubleshooting and maintenance procedure for PLC
6. Observation of Troubleshooting and maintenance procedure for robots in manufacturing.
7. Case study on Troubleshooting and maintenance procedure for Medical robots

Reference Book

1. Frank lamb, Maintenance and Troubleshooting in Industrial Automation.
2. Programmable Logic Controllers, Principles and Applications"; John W. Webb, Ronold A Reis, 5th Edition, Prentice Hall of India Pvt. Ltd
3. Mark R Miler, Rex Miler ,Robots and Robotics principle system and industrial application
4. B Xing,TshilidziMarwala ,Smart Maintenance for Human- Robot Interaction Springer publication

ROBOTIC PROGRAMMING-I

(Course No.)

Designation of Course	**Robotics Programming-I**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- -- Hours/ Week	End Semester Examination	-- Marks	--
Tutorial:- -- Hours/ Week	Internal Assessment	-- Marks	
Practical:- 04 Hours/ Week	Term Work	25 Marks	02
	Oral/Practical	25 Marks	
	Total	**50 Marks**	**02**

Course Prerequisite:-	1. Programming language C++/Python /MATLAB
Course Objective:-	To provide Knowledge about 1. To Understand different types of robot programming 2. To learn different robot commands 3. To understand different robot programming applications
Course Outcomes:-	On completion of the course, students will be able to 1. Classify different programming languages 2. Identify and execute different commands in VAL-I 3. Identify and execute different commands in VAL-II 4. Identify and execute different commands in RAPID 2. 5.Develop robot simulation model in Virtual software 3. 6.develop robot programming applications

Course Content

Unit I	**Basics of Robot Programming**	**(08 Hrs.)**
Robot programming-Introduction-Types- Flex Pendant- Lead through programming, Coordinate systems of Robot, Robot controller- major components, functions-Wrist Mechanism-Interpolation-Interlock commands Operating mode of robot, Jogging Types, Robot specifications- Motion commands, end effectors and sensors commands		
Unit II	**VAL Language**	**(08 Hrs.)**
Robot Languages-Classifications, Structures- VAL language commands- motion control, hand control, program control, pick and place applications, palletizing applications using VAL, Robot		

welding application using VAL program-WAIT, SIGNAL and DELAY command for communications using simple applications		
Unit III	**VAL-II**	**(08 Hrs.)**
VAL-II programming-basic commands, applications- Simple problem using conditional statements-Simple pick and place applications-Production rate calculations using robot. AML Language-General description, elements and functions, Statements, constants and variables-Program control statements- Operating systems, Motion, Sensor Commands-Data processing.		
Unit IV	**RAPID Language**	**(08 Hrs.)**
RAPID language basic commands- Motion Instructions-Pick and place operation using Industrial robot- manual mode, automatic mode, subroutine command-based programming. Move master command language-Introduction, syntax, simple problems		
Unit V	**Practical Study of Virtual Robot**	**(08 Hrs.)**
Robot cycle time analysis-Multiple robot and machine Interference-Process chart Simple Problems-Virtual robotics, Robot studio online software-Introduction, Jogging, components, work planning, program modules, input and output signals-Singularities Collision Detection-Repeatability measurement of robot-Robot economics., Simulation by roboMaster and Siemens PLCNXCD		
Unit VI	**Robot Programming Applications**	**(08 Hrs.)**
Robot programming synthesis, robot programming for foundry, press work and heat treatment, welding, machine tools, material handling, warehousing assembly, etc., automatic storage and retrieval system, Robot economics and safety, Robot integration with CAD/CAM/CIM, Collision free motion planning		

Term Work

1. Write a program for palletizing operation by robot
2. Write a program for depalletizing operation by robot
3. Write a program for Pick Place operation by robot
4. Write a program for Assembly operation by robot
5. Write a program for gauge inspection operation by robot
6. Write a program for Welding operation by robot manipulator
7. Write a program for interfacing of robot manipulator with CNC Machine
8. Write a program for object sorting by robot manipulator based on colour , shape, material etc.

Text Book

1. Deb. S. R. "Robotics Technology and Flexible Automation", Tata McGraw Hill publishing company limited.
2. Mikell. P. Groover, "Industrial Robotics Technology", Programming and Applications, McGraw Hill Co, 1995.
3. Klafter. R.D, Chmielewski.T.A and Noggin's, "Robot Engineering: An Integrated Approach", Prentice Hall of India Pvt. Ltd.,1994

Reference Book

1. Fu .K. S, Gonzalez .R. C. & Lee .C.S.G, "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill Book co, 1987.
2. Craig .J. J, "Introduction to Robotics Mechanics and Control", Addison- Wesley, 1999.
3. Robotics Lab manual, 2007.

Sem VII

ADVANCED ROBOTICS

(Course No. C 401)

Designation of Course	**Advanced Robotics**		
Teaching Scheme:	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/Week	End Semester Examination	60	03
Practical: 02 Hours/Week	Internal Assessment	40	01
Tutorial : 01 Hours/Week	Term Work	25 Marks	01
	Oral	25 Marks	
	Total	**150 Marks**	**05**

Course Prerequisites: -	1. Basics of Robotics 2. Data Storage System 3. Applied Mechanics
Course Objectives: -	To provide knowledge about 1. Robotic machine used in smart manufacturing 2. Data storage and capturing techniques 3. Robotics application in Smart manufacturing
Course Outcomes: -	The students should be able to 1. To Understand Smart Material Handling Technologies 2. To Understand Data Storage and Capturing system 3. To Select Industrial Manipulator for application 4. To Design Robot End Effector 5. To Understand robot application in Manufacturing 6. To Understand Advanced robot application

Course Contents

Unit-I	**Introduction to Smart Material handling Techniques**	**08 Hrs.**
Principles of Smart Material Handling, Design consideration for smart storage system, Unit load concept, Material Handling equipment, Material transport systems: AGVs, Monorails, Conveyor systems, Cranes and hoists, Analysis of material transport systems: Charting technique, analysis of vehicle-based systems, Conveyor analysis		
Unit-II	**Storage and Data Capturing Systems**	**08 Hrs.**
Conventional storage methods and equipment's Storage system performance, Analysis of Automated storage/retrieval systems (ASRS) and Carousel Storage system. Automatic data capturing system (ADC), Bar coding, Radio frequency identification (RFID), Optical character recognition, Magnetic stripes		
Unit-III	**Industrial Robot**	**08 Hrs.**
Types of industrial robots, Load handling capacity, general considerations in Robotic material handling, material transfer, machine loading and unloading, CNC machine tool loading, Robot cantered cell.		
Unit-IV	**End Effector Design**	**08 Hrs.**
Classification, Design consideration, Materials for hostile operation. Cylindrical Cam type; Grippers using pneumatic, hydraulic, and electrical motor for transmission; Vacuum Grippers, Ultrasonic grippers. Gripper force analysis and gripper design, design of multiple degrees of		

freedom, active and passive grippers. Selection of Robot: Factors influencing the choice of a robot, robot performance testing, economics of robotization, Impact of robot on industry and society.		
Unit-V	**Application of Robots in Smart Manufacturing**	**08 Hrs.**
Pick and place Robot, Application of Robots in Arc Welding Robots, Assembly and mega-assembly Robots continuous arc welding, Spot welding, Spray painting, assembly operation, Other industrial applications: Coating, Deburring, cleaning, Die Casting, Molding, Material handling, Picking, Palletizing, Packaging Robots For Inspection: Robotic vision systems, image representation, object recognition and categorization, depth measurement		
Unit-VI	**Advanced Application of Robots**	**08 Hrs.**
Military and medical applications, robot for underwater applications Robots, Climbing Robots, Machine mounted Robots. Interfacing Robots with computers. Obstacle Avoidance: Lee's Algorithm; Counter Path Defining using 'via' point, blending.		

Term Work:

Term work shall consist record of minimum 8 experiments from the following.

1. Study of Smart Material handling systems with any Simulation tool
2. Demonstration of Flexible Manufacturing System for various application
3. Study and analysis of Storage and Data capturing systems
4. Study of different Industrial Robot application with any Simulation tool
5. Demonstration of pick and place application by industrial robot
6. Study and analysis of robot grippers (includes the problems based on gripper force)
7. Case Study on advanced industrial applications of robots
8. Case Study of Medical robot
9. Case Study of robot for any Military application

Project Based Learning: -

1. To Prepare prototype of smart manufacturing for various machining operation
2. To prepare prototype of FMS
3. To prepare chart/poster of Flexible Manufacturing system
4. To prepare chart/poster of data storage and capturing system
5. To prepare Barcode reader robotic manipulator
6. To prepare model of robot manipulator interfacing with prototype of CNC
7. To design and prepare protype of robot manipulator with any type of gripper
8. To prepare prototype model of robot for any military application

Textbooks:

1. M.P. Groover, "Automation, Production Systems & Computer Integrated Manufacturing", PHI, 3rd Edition, 2012.

2. M.P. Groover, M.Naegel, "Industrial Robotics, Technology, Programming & Applications", TMH,2nd Edition, 2012.

3. S.K.Saha "Introduction to Robotics", The McGraw Hills company.

References Books:

1. Deb S.R., “Robotics”, Tata McGraw Hill Publications, New Delhi. ISBN 13: 9780070077911
2. Yoram Koren, & quot; Robotics for Engineers", McGraw Hill Book Co. ISBN-10: 0070353999
3. Fu K.S., Gonzalex R.C., Lee C.S.G., "Robotics Control Sensing, Vision and intelligence", McGraw Hill Book Co. ISBN 10: 0070226253 / ISBN 13: 9780070226258
4. Todd D.J., “Fundamentals of Robot Technology”, Wiley Publications, ISBN:978-0-470-20301-9

Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

El-I SIX SIGMA, LEAN & AGILE MANUFACTURING
(Course No. C 402.1)

Designation of Course	**Six sigma, Lean & Agile Manufacturing**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 3 Hours/ Week	End Semester Examination	60	03
Practical: - 02 Hours/ Week	Internal Assessment	40	01
	Term Work	25 Marks	
	Total	**125 Marks**	**04**

Course Prerequisites: -	Student should have knowledge of 1. Students should have Basic knowledge of Industrial Engineering. 2. Students should have Basic knowledge of Statistics
Course Objectives: -	Student should be able to 1. Use of six sigma technique to reduce variation 2. Use of Lean manufacturing for process improvement 3. Use of Agile manufacturing
Course Outcomes: -	Learner will be able to… 1. Understand and work with the Lean manufacturing process 2. Understand and work with the Agile Production System 3. Management in the Agile Organization. 4. Understand basic statistical processes. 5. Understand and calculate the six sigma levels 6. Understand and work with the DMAIC process

Course Contents

Unit 1	**Lean Manufacturing**	**06 Hrs.**

Origin and objectives of lean manufacturing, 3M concept, study of Ford and Toyota Production system, Just in Time (JIT) manufacturing, lean building blocks.

Value Creation and Waste elimination, seven types of waste, pull production, different models of pull production, Kanban system, design of Kanban quantities, Kaizen, tools for continuous improvement.

The value stream-benefits, mapping process. Current state maps-mapping icons, mapping steps. VSM exercise. Takt time calculations standardize work- standard work sequence, timing and working progress

Quality at source-Automation/Jidoka, Visual management system, Mistake Proofing/Poka-Yoke.5s technique-Elements and waste elimination through 5s. advantages and benefits, 5s audit, Visual control aids for improvements, Flexible work force.

Unit 2	**Agile Production system and Practices**	**06 Hrs.**

Agile production system-the task allied organization-production planning and control, quality assurance, purchasing maintenance, overview of production support, business operations, engineering, finance and accounting. Agile Practices-Agile practice for product development, manufacturing Agile practice, understanding the value of investment in people.

Unit 3	**Management in the Agile Organization**	**06 Hrs.**
Old management styles, role of management in agile organization-vision champion, team leader, coach, business analyzer, supporting the new culture-performance appraisal system, selection system, reward and recognition system, organizational measurement, organizational learning processes.		
Unit 4	**Statistics and probability distribution**	**06 Hrs.**
Basic statistics, probability distributions, normal distribution, central limit theorem, measurement system analysis – precision, accuracy, bias, linearity, gage repeatability & reproducibility. Process capability analysis. Multi-Variate analysis, sampling techniques, Hypothesis testing, testing with normal data, One Way ANOVA, nonparametric tests for non-normal data. Chi-square tests		
Unit 5	**Introduction to Six Sigma**	**06 Hrs.**
Six Sigma Defined, Calculating the Sigma Level – Toolset, Six Sigma Framework, DMAIC – The Six Sigma Improvement Process, Introduction to Measure, Introduction to Define, Process Thinking, Spaghetti Charts, Value Stream Mapping Toolset, Pareto Chart Toolset, Project Selection Toolset, Project Charter Toolset		
Unit 6	**Six Sigma in manufacturing**	**06 Hrs.**
Introduction to Measure, Measurements, Discrete vs. Continuous Measurements, Measurement Subjects, Measurement as a Process, The Analysis of Measurement Systems, Statistical Process Control – Introduction and Background, Introduction to Control Charts , Control Chart Limits, More On Control Limits, Cause & Effect Diagram Toolset, Introduction to Hypothesis Testing, The Process on Trial, The Hypothesis – Accept or Reject, Types of Error, Hypothesis Testing , Confidence Intervals, Design of Experiments, Design for Six Sigma (DFSS), Benchmarking , Brainstorming		

Term Work:

1. Case study on Just in Time system
2. Case study on Toyota production system
3. Case study on Kanban and Kaizen production system
4. Case study on Management in the Agile Organization
5. To find the Process capability.
6. Application of Chi-square tests
7. Case study on Sigma level calculations.
8. Case study on design of Experiment.

Project Based Learning

1. Chart preparation showing different methods of waste elimination.
2. Chart preparation for showing the various elements of JIT system.
3. Study of a system based on value stream mapping.
4. Demonstration of elimination of waste using 5S system.
5. Demonstration of Cause and effect diagram for a system.
6. Demonstration of control charts for a system.
7. Study of system using Six sigma for reduction in variation.
8. Formulation of Hypothesis, testing and analysis.

Textbooks:

1. Jain R. K., "Engineering Metrology", Khanna Publishers
2. Hume K. J., "Engineering Metrology", Macdonald, 1950
3. Sharp K. W. B., "Practical Engineering Metrology", Pitman Publication, 1970.

Reference Book:

1. Productions and Operations Management - Chasel Aquilino - Dreamtech latest edition.
2. Toyota Production System -An integrated approach to Just in Time - Yasuhiro Monden – Engineering and Management Press -Institute of Industrial Engineers Norcross Georgia-1983.
3. The Machine that changed the World. The Story of Lean Production - James P Womack – Daniel T Jones - and Daniel Roos -Harper Perennial - edition published 1991.
4. Lean Thinking - James Womack – ISBN 0743249275 – 2003.
5. Japanese Manufacturing Techniques. The Nine Hidden Lessons by simplicity - Richard Stumberger - ASQC Press 1991.
6. Quality Function Development - James Bossert - ASQC Press 1991.

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

El-I Engineering Economics
(Course No. C 402.2)

Designation of Course	**Engineering Economics (Elective -I)**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial: - --Hours/ Week	Internal Assessment	40 Marks	
Practical: - 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	-- Marks	
	Total	**125 Marks**	**04**

Course Prerequisites: -	The students should have knowledge of Basic of Mathematics
Course Objectives: -	Students will be able to understand the economics behind running a successful engineering project
Course Outcomes: -	Student should be able to 1. Understand the basic concepts of economics any apply them for selection and planning 2. Understand time value of money and calculate the value of money at any given time in a project 3. Understand Basic Methodologies of Engineering Economic Analysis and use them to for selection of project 4. Use various methods to compare two different projects to check their viability 5. Use replacement analysis for panning and changing of resources in a project 6. Plan for Depreciation and Corporate Income Taxes

Course Contents

Unit 1	**Introduction to Economics**	**(06 Hrs.)**
Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis – V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning.		
Unit 2	**Interest and Time Value of Money**	**(06 Hrs.)**
Introduction to Time Value of Money; Simple Interest; Compound Interest; Nominal Interest rate; Effective Interest rate; Continuous Compounding; Economic Equivalence; Development of Interest Formulas; The Five Types of Cash flows; Single Cash flow Formulas; Uneven Payment Series; Equal Payment Series; Linear Gradient Series; Geometric Gradient Series.		
Unit 3	**Basic Methodologies of Engineering Economic Analysis**	**(06 Hrs.)**
Minimum Attractive (Acceptable) Rate of Return (MARR); Payback Period Method; Equivalent Worth Methods: Present Worth Method, Future Worth Method, Annual Worth Method; Rate of Return Methods: Internal Rate of Return Method; External/Modified Rate of Return Method; Public		

Sector Economic Analysis (Benefit Cost Ratio Method); Introduction to Lifecycle Costing; Introduction to Financial and Economic Analysis		
Unit 4	**Comparative Analysis of Alternatives**	**(06 Hrs.)**
Comparing Mutually Exclusive Alternatives having Same useful life by 1. Payback Period Method and Equivalent Worth Method 2. Rate of Return Methods and Benefit Cost Ratio Method Comparing Mutually Exclusive Alternatives having different useful lives by 1.Repeatability Assumption 2.Co-terminated Assumption 3.Capitalized Worth Method Comparing Mutually Exclusive, Contingent and Independent Projects in Combination.		
Unit 5	**Replacement Analysis**	**(06 Hrs.)**
Fundamentals of Replacement Analysis: Basic Concepts and Terminology; Approaches for Comparing Defender and Challenger; Economic Service Life of Challenger and Defender Replacement Analysis When Required Service Life is Long: Required Assumptions and Decision Framework; Replacement Analysis under the Infinite Planning Horizon; Replacement Analysis under the Finite Planning Horizon		
Unit 6	**Depreciation and Corporate Income Taxes**	**(06 Hrs.)**
Concept and Terminology of Depreciation; Basic Methods of Depreciation: Straight line method, Declining Balance Method, Sinking Fund Method, Sum of the Year Digit Method, Modified Accelerated Cost Recovery System (MACRS); Introduction to Corporate Income Tax; After Tax Cash flow Estimate; General Procedure for Making After Tax Economic Analysis.		

Term Work

1. Completing a break even analysis of a company
2. Calculation of time value of money
3. Calculating the feasibility of a project by economic analysis
4. Comparing Mutually Exclusive Alternatives having Same useful life by Payback Period Method and Equivalent Worth Method
5. Comparing Mutually Exclusive Alternatives having Same useful life by Payback Rate of Return Methods and Benefit Cost Ratio Method
6. Comparing Mutually Exclusive Alternatives having different useful lives
7. Replacement analysis of a machine
8. Calculation of depreciation of a machine
9. Calculation of corporate taxes.

Project Based Learning

1. Case study on break even analysis of a company
2. Case study on Calculation of time value of money
3. Case study on feasibility of a project by economic analysis
4. Case study on Comparing Mutually Exclusive Alternatives having Same useful life by Payback Period Method and Equivalent Worth Method
5. Case study on Comparing Mutually Exclusive Alternatives having Same useful life by Payback Rate of Return Methods and Benefit Cost Ratio Method
6. Case study on Comparing Mutually Exclusive Alternatives having different useful lives
7. Case study on Replacement analysis of a machine
8. Case study on Calculation of depreciation of a machine
9. Case study on Calulation of corporate taxes.

Textbooks

1. R. Paneerselvem, Engineering Economics, Prentice Hall India.
2. M.P. Groover, "Automation, Production Systems & Computer Integrated Manufacturing", PHI, 3rd Edition, 2012.

Reference Books

1. Chan S. Park, Contemporary Engineering Economics, Prentice Hall, Inc.
2. E. Paul De Garmo, William G. Sullivan and James A. Bonta delli,Engineering Economy, MC Milan Publishing Company.
3. James L. Riggs, David D. Bedworth and Sabah U. Randhawa,Engineering Economics, Tata MCGraw Hill Education Private Limited.

Unit Tests

Unit Test-I	Unit- I,II, III
Unit Test-II	Unit- IV, V, VI

El-I ARGUMENTED AND VIRTUAL REALITY
(Course No. C 402.3)

Designation of Course	**Augmented and Virtual Reality**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**04**

Course Prerequisites: -	Companion Course, if any: Virtual Reality Lab
Course Objectives: -	This course is designed to give historical and modern overviews and perspectives on virtual reality. It describes the fundamentals of sensation, perception, technical and engineering aspects of virtual reality systems.
Course Outcomes: -	The students should be able to– 1. Describe how VR systems work and list the applications of VR. 2. Understand the design and implementation of the hardware that enables VR systems to be built. 3. Understand the Geometry of Virtual Worlds &The Physiology of Human Vision. 4. Understand the system of human vision and its implication on perception and rendering. 5. Explain the concepts of motion and tracking in VR systems. 6. Describe the importance of interaction and audio in VR systems.

Course Contents

Unit I	**Introduction to Virtual Reality**	**(06Hrs.)**
Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality.		
Unit II	**Representing the Virtual World**	**(06 Hrs.)**
Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR		
Unit III	**The Geometry of Virtual Worlds &The Physiology of Human Vision**	**(06 Hrs.)**
Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.		
Unit IV	**Visual Perception & Rendering**	**(06 Hrs.)**
Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information Visual Rendering -Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates		

Unit V	Motion & Tracking	(06 Hrs.)
Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies		
Unit VI	**Interaction & Audio**	**(06 Hrs.)**
Interaction - Motor Programs and Remapping, Locomotion, Manipulation, Social Interaction. Audio -The Physics of Sound, The Physiology of Human Hearing, Auditory Perception, Auditory Rendering.		

Term Work

1. Installation of Unity and Visual Studio, setting up Unity for VR development, understanding documentation of the same.
2. Study and demonstration of depth perception.
3. Study and demonstration of skeleton tracking for various application
4. Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR.
5. Develop a scene in Unity that includes a cube and apply transformations on the 3 game objects.
6. Develop a scene in Unity that includes a plane and apply transformations on the 3 game objects
7. Develop a scene in Unity that includes a sphere and apply transformations on the 3 game objects
8. Develop a scene in Unity that includes a video source
9. Develop a scene in Unity that audio source.

Project Based Learning

1. Study the use of Virtual Reality at NASA
2. GHOST (General Haptics Open Software Toolkit) software development toolkit.
3. Sweeping coverage of eye movements
4. Automatic stitching of panoramas in Virtual Reality
5. A virtual Study Use Case- NICE, An Educational Experience
6. Side effects of using VR systems/ VR sickness.

Text Books

1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002
3. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.

Reference Books

1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Meging Real and

Virtual Worlds", 2005.
4. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003

Unit Tests

Unit Test-I	Unit-I,II, III
Unit Test-II	Unit-IV, V, VI

El-I OPERATIONS RESEARCH

(Course No. C 402.4)

Designation of Course	**Operations Research**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Lectures: - 03 hours/Week	End Semester Examination	60 Marks	3
Practical: - 02 hours/Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	1
	Practical	-	-
	Total	**125 Marks**	**4**

Course Prerequisites:	Good knowledge of mathematics.
Course Objective: -	The students will be able to understand various models in operations research used in industries to solve problems
Course Outcomes	As a part of this course, students will: 1. Understand OR problem and associated models. 2. Understand Linear Algebra. 3. Use transportation and assignment problems. 4. Use PERT for modelling. 5. Use Inventory Control System. 6. Apply queuing theory and modulation techniques.

Course Contents

Unit 1	**Introduction to Operation Research**	**(06 Hrs.)**
Origin of OR and its definition. Concept of optimizing performance measure, Types of OR problems, Deterministic vs. Stochastic optimization, Phases of OR problem approach – problem formulation, building mathematical model, deriving solutions, validating model, controlling, and implementing solution.		
Unit 2	**Linear Programming:**	**(06 Hrs.)**
Linear programming – Examples from industrial cases, formulation & definitions, Matrix form. Implicit assumptions of LPP. Some basic concepts and results of linear algebra – Vectors, Matrices, Linear Independence/Dependence of vectors, Rank, Basis, System of linear eqns., Hyperplane, Convex set, convex polyhedron, Extreme points, Basic feasible solutions. Geometric method: 2-variable case, Special cases – infeasibility, unboundedness, redundancy & degeneracy, Sensitivity analysis. Simplex Algorithm – slack, surplus & artificial variables, computational details, big-M method, identification, and resolution of special cases through simplex iterations. Duality – formulation, results, fundamental theorem of duality, dual-simplex and primal-dual algorithms.		
Unit 3	**Transportation and Assignment problems:**	**(06 Hrs.)**
TP - Examples, Definitions – decision variables, supply & demand constraints, formulation, Balanced & unbalanced situations, Solution methods – NWCR, minimum cost and VAM, test for optimality (MODI method), degeneracy and its resolution. AP - Examples, Definitions – decision variables, constraints, formulation, Balanced &unbalanced situations,		

Solution method – Hungarian, test for optimality (MODI method), degeneracy & its resolution.		
Unit 4	**PERT – CPM:**	**(06 Hrs.)**
Project definition, Project scheduling techniques – Gantt chart, PERT & CPM, Determination of critical paths, Estimation of Project time and its variance in PERT using statistical principles, Concept of project crashing/time-cost trade-off.		
Unit 5	**Inventory Control**	**(06 Hrs.)**
Functions of inventory and its disadvantages, ABC analysis, Concept of inventory costs, Basics of inventory policy (order, lead time, types), Fixed order-quantity models – EOQ, POQ & Quantity discount models. EOQ models for discrete units, sensitivity analysis and Robustness, Special cases of EOQ models for safety stock with known/unknown stock out situations, models under prescribed policy, Probabilistic situations.		
Unit 6	**Queuing Theory**	**(06 Hrs.)**
Definitions – queue (waiting line), waiting costs, characteristics (arrival, queue, service discipline) of queuing system, queue types (channel vs. phase). Kendall's notation, Little's law, steady state behavior, Poisson's Process & queue, Models with examples - M/M/1 and its performance measures; M/M/m and its performance measures; brief description about some special models. **Simulation Methodology:** Definition and steps of simulation, random number, random number generator, Discrete Event System Simulation – clock, event list, Application in Scheduling, Queuing systems and Inventory systems.		

Term work

Term work shall consist of any eight programs described in syllabus and listed below.

1. Solution of linear programming problem using graphical method
2. Solution of linear programming problem with simplex method.
3. Problem solving using Big M method.
4. Problem solving using two phase method.
5. Solution of transportation problem.
6. Solution of assignment problem.
7. Identification of project duration using CPM
8. Finding probabilities of project completions using PERT
9. Performance measures for M/M/1 queuing model.
10. Determination of various inventory cost using inventory model.

List of Project Based Learning Topics:

1. Students must work on one of the projects listed below (but not limited to) during the semester.
2. Find the companies that used OR as a tool to sort a problem successfully and unsuccessfully. Compare them and analyse as to why certain strategies worked and others failed.
3. Visit any industry and choose one of their products. Develop a LPP for maximizing profits on the sale of that product considering the various constraints on it. Solve the LPP and make suggestions of the same for the company.
4. Develop a software that helps in making timetable for the department by making and solving an LPP.
5. Visit a small departmental store/hotel, collect data, and make an LPP for optimum use of space. Solve the LPP and make relevant suggestions.

6. Write a research paper on how LPP helps companies to solve problems referencing latest papers.
7. Write a research paper on how assignment tools help companies to solve problems referencing latest papers.
8. Write a research paper on how transportation tools help companies to solve problems referencing latest papers.
9. Visit a small-scale industry. Collect data and make WBS and a network diagram. Solve it by CPS and PERT methods ad make relevant suggestions.
10. Write a research paper on how network analysis tools help companies to solve problems referencing latest papers.
11. Write a research paper on how queuing models help companies to solve problems referencing latest papers.
12. Go to a nearby petrol pump, bank, departmental store, hotel. Record the arrival and service rates for multiple day. Analyze the data and make relevant suggestions.
13. Write a research paper on how inventory models help companies to solve problems referencing latest papers.
14. Go to a nearby petrol pump, departmental store, hotel. Record inventory levels and inventory practices for multiple day. Analyze the data and make relevant suggestions.

Textbooks:

1. Operations Research: An Introduction. H.A. Taha.
2. Introduction to Operations Research. F.S. Hiller and G.J. Lieberman.
3. Principles of OR with Application to Managerial Decisions. H.M. Wagner.

Reference Books:

1. Linear Programming. K.G. Murthy.
2. Linear Programming. G. Hadley.
3. Elements of Queuing Theory. Thomas L. Saaty.
4. Operations Research and Management Science, Handbook: Edited by A. Ravi Ravindran.
5. Management Guide to PERT/CPM. Wiest& Levy.
6. Modern Inventory Management. J.W. Prichard and R.H. Eagle.

Unit Tests:

Unit Test-I	Unit-I,II, III
Unit Test-II	Unit-IV, V, VI

INDUSTRIAL INTRNET OF THINGS

(Course No. C 403)

Designation of Course	**Industrial Internet of Things**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 4 Hours/ Week	End Semester Examination	60 Marks	4
Practical: - 2 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25Marks	1
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**5**

Course Prerequisites: -	Systems in Mechanical Engineering, Programming and Problem Solving, Basic Electronics Engineering, Solid Mechanics, Solid Modeling and Drafting, Electrical and Electronics Engineering, Mechatronics, Measurement Laboratory, Fluid Power & Control Laboratory
Course Objectives: -	1. Introduction to IoT, Overview of IoT Building Blocks 2. Build small applications in IoT for Mechanical Engineering Applications using Sensors, Actuators, Microcontrollers and Cloud 3. Learn commonly used IoT Simulation Hardware platforms 4. Understand different Communication Technologies used in IoT 5. Development of application-level protocol and Security of IoT Ecosystem 6. Understand IoT applications in different domains
Course Outcomes: -	On completion of the course the learner will be able to; 1. EXPLAIN the Applications/Devices, Protocols and Communication Models of IoT 2. DEMONSTARTE small Mechanical Engineering IoT oriented applications using Sensors, Actuators, Microcontrollers and Cloud 3. SELECT commonly used IoT Simulation Hardware platforms 4. APPLICATION of Interfacing and Communication Technologies for IoT 5. ILLUSTRATE IoT Application Development and Security of IoT Ecosystem 6. EVALUATE Present and Future Domain specific Applications of IoT Ecosystem

Course Contents

Unit I	**Introduction to Industrial Internet of Things Systems**	**(08Hrs.)**
The Various Industrial Revolutions, Role of Internet of Things (IoT) & Industrial Internet of Things (IIoT) in Industry, Industry 4.0 revolutions, Support System for Industry 4.0, Smart Factories.		
Unit II	**Implementation System for IIoT**	**(08 Hrs.)**
Sensors and Actuators for Industrial Processes, Sensor networks, Process automation and Data Acquisitions on IoT Platform, Microcontrollers and Embedded PC roles in IIoT, Wireless Sensor nodes with Bluetooth, WiFi, and LoRa Protocols and IoT Hub systems.		

Unit III	IIoT Data Monitoring & Control	(08 Hrs.)
IoT Gate way, IoT Edge Systems and It's Programming, PLC and Wi-Fi enabled system, Cloud computing, Real Time Dashboard for Data Monitoring, Data Analytics and Predictive Maintenance with IIoT technology.		
Unit IV	**Cyber Physical Systems**	**(08 Hrs.)**
Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis		
Unit V	**Industrial IoT- Applications**	**(08 Hrs.)**
Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management.		
Unit VI	**Case Studies of IIoT Systems**	**(08 Hrs.)**
IIoT application development with Embedded PC based development boards, Development of mini-Project on new version of Operating systems and Edge development board. That project should also address to the current societal needs		

Term Work

1. Study of various application of internet on things in industry
2. Demonstration of Electro-Hydraulic system for Data storage and optimization using IoT
3. Demonstration of Electro-Pneumatic system for Data storage and optimization using IoT
4. Demonstration of PLC based Traffic light control system for Data storage and optimization using IoT
5. Development of IoT Cloud for classroom monitoring and generation of graphical result
6. Demonstration of any health monitoring application using IoT tools
7. Demonstration of automated toll collection system (using FASTTAG).
8. Industrial visit to any relevant organization where IoT based tool is implemented.

Project Based Learning

Students have to prepare and submit a demonstration models based on above syllabus.
Prepare a model/a chart/a case study based on following topic (Not limited to this)

1. Industrial Internet of Things in industry
2. Industrial Internet of Things system implementation element
3. IoT data Monitoring and control by PLC/Wi-Fi
4. Preductive maintenance in IIoT
5. Cyber physical system
6. IoT application for health care /Power plant/Quality control system

Text Books

1. daCosta, F., (2013), "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", Apress Publications, ISBN: 9781430257417
2. Waher, P., (2015), "Learning Internet of Things," Packt Publishing, ISBN: 9781783553532
3. Ovidiu, V. and Friess, P., (2014), "Internet of Things - From Research and Innovation to Market Deployment," River Publishers, ISBN: 9788793102941,

4. Ida, N., (2020), “Sensors, Actuators and Their Interfaces,” SciTech Publishers, ISBN: 9781785618352
5. Pfister, C., (2011), “Getting Started with the Internet of Things,” O’Reilly Media, ISBN: 9781449393571

Reference Books

1. Bahga, A. and Madisetti, V., (2015), “Internet of Things - A Hands-on Approach,” Universities Press, ISBN: 9788173719547
2. Hajjaj, S S H. and Gsangaya, K. R., (2022), “The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers,” CRC Press, ISBN: 9781032110950
3. Raj, P. and Raman, A. C., (2017), “The Internet of Things: Enabling Technologies, Platforms, and Use Cases,” Auerbach Publications/CRC Press, ISBN: 9781498761284
4. Adrian McEwen, A. and Cassimally, H., (2013), “Designing the Internet of Things,” John Wiley and Sons, ISBN:
5. Veneri, G., Capasso, A., (2018), “Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0,” Packt Publishing, ISBN: 9781789537222
6. Hersent, O, Boswarthick, D., Elloumi, O., (2012), “The Internet of Things: Key Applications and Protocols”, Wiley, ISBN: 9781119994350 7. Uckelmann, D., Harrison, M., Michahelles, F., (2011), “Architecting the Internet of Things,” Springer, ISBN: 9781119994350

Unit Tests

Unit Test-I	Unit-I,II, III
Unit Test-II	Unit-IV, V, VI

FUTUTE FACTORY

(Course No. C 404)

Designation of Course	**Future Factory**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
	Internal Assessment	40 Marks	
Practical: - 02 Hours/ Week	Term Work	25 Marks	01
	Total	**125 Marks**	**04**

Course Prerequisites: -	The students should have knowledge of 1) Manufacturing Technology-I, II 2) Automatic Control System 3) Electro-Hydraulic and Pneumatics 4) Power Electronics & Drives 5) Object Oriented Programming (Using Python) 6) Programmable Logic Controller
Course Objectives: -	To provide Knowledge about 1. Modern manufacturing systems 2. To understand the concepts and applications of flexible manufacturing systems 3. To introduce the concept of smart factories, especially the various technologies involved within the smart manufacturing. 4. To introduce the applications and scope for technology involved in Industry 4.0.
Course Outcomes: -	The students should be able to– 1. Recognize the recent manufacturing trends related to Industry 4.0, FMS, and its implementation in manufacturing 2. Perform Planning, Scheduling, and control of Flexible Manufacturing systems 3. Identify the role of cloud manufacturing for smart factories, challenges, and scope 4. Understand and apply the concept of agile manufacturing and cyber security in future factory 5. Identify applications of AR and VR in smart manufacturing. 6. Understand and apply the concept of digital twins in future factory

Course Contents

Unit I	**Introduction to smart manufacturing technologies**	**(06 Hrs.)**
Introduction to Industry 4.0, Smart manufacturing, Related technologies, Traditional Factory and Smart Factory, The Smart Factory Opportunity, CIM wheel, CIMS Structure and Functions, Future Trends of smart Factory and applications. Introduction & composition of FMS, hierarchy of computer control, computer control of work center and assembly lines, FMS supervisory computer control, types of software specification and selection.		
Unit II	**Applications of FMS and factory of the future**	**(06 Hrs.)**
FMS application in machining, sheet metal fabrication, prismatic component production, aerospace application, FMS development towards factories of the future. Flexibility rules, Sustainability, Man in the factory, building blocks for the factory of the future, Building architecture and factory planning, IT Infrastructure and cyber security, Data Management, Machines and manufacturing systems.		

Unit III	Cloud Manufacturing and connected factory	(06 Hrs.)
Introduction to Cloud computing, Industrial Internet of Things, supply chain management, Big Data and Analytics, Big Data decision-making, , Automotive Cloud, warehouse operations, Augmented reality. Virtualization, Cloud Platforms, Big data in production, Cloud-based ERP and MES solutions, Connected factory applications, IT security for cloud applications.		
Unit IV	**Agile Manufacturing and Safety with Future Factory**	**(06 Hrs.)**
Agile Manufacturing: Introduction to Agile Manufacturing, Agile Manufacturing Principles, Implement Agile Manufacturing, Applications of Agile Manufacturing, Real-Time Data to Guide Iteration, Computer Vision to Augment Operators, Manufacturing Apps to Amplify Training Programs, Mass Customization. **Safety with Future Factory**: Introduction to cybersecurity, security principles, risk and opportunities in cybersecurity technology,		
Unit V	**Virtual and Augmented Reality, Machine Learning in Industry 4.0**	**(06 Hrs.)**
Introduction, Difference in AR and VR, Hardware and Software Technology, Industrial Applications of Augmented reality and Virtual reality. Basics of Machine Learning, The Machine Learning Process, Into Machine Learning working cycle, Preparing Data, Running Experiments, Finding the Model, Training the Model, Deploying and using a Model, Machine Learning in practice (examples of existing or future applications in the field of manufacturing)		
Unit VI	**Digital Twins**	**(06 Hrs.)**
Introduction to Digital Twins, Benefits, impact and challenges, Features and Implementation of Digital Twins, Computational tools, Types of Digital Twins, Applications for digital twins in production (examples of existing or future applications in the field of manufacturing), digital twin in dynamical systems, Data-driven digital twins, methods in digital twin technology, Deep learning in digital twin technology.		

Term Work

List of Practical /Term work: -

(Term work shall consists of minimum 8 experiments based on above syllabus)

1. Study of FMS/CIM/Industry 4.0 technology in smart manufacturing applications.
2. Study of different applications of FMS and factory of future
3. Case studied on cloud manufacturing
4. Study of Cloud-based ERP.
5. Study of Agile manufacturing in smart manufacturing applications
6. Study of cyber security and its different applications in future factory
7. Design and Simulation of process automation using simulation software
8. Study of integration of robotics system with CNC Machine
9. Study of factory simulation using simulation software
10. Industrial visit to Automation Factory

Project Based Learning

Students have to prepare and submit a demonstration models based on above syllabus.

Prepare a model/a chart/a case study based on following topic (Not limited to this)

1. FMS/CIM/Industry 4.0 technology
2. Smart manufacturing
3. Cloud-based ERP
4. Agile Manufacturing
5. Safety with Future Factory
6. Use of Virtual and Augmented Reality for industrial applications.
7. Machine Learning working cycle

8. Digital Twins
9. Cyber security for mechanical industry.

Textbooks

1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press,2020
2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
3. Parag Kulkarni and Prachi Joshi, "Artificial Intelligence – Building Intelligent Systems", PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015
4. Stuart Russell and Peter Norvig (1995), "Artificial Intelligence: A Modern Approach," Third edition, Pearson, 2003
5. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India Pvt., New Delhi, 1996.
6. Kalpakjian, "Manufacturing Engineering and Technology", Addison-Wesley Publishsing Co., 1995.
7. Taiichi Ohno, "Toyota Production System: Beyond large-scale Production", Productivity Press (India) Pvt. Ltd. 1992.
8. Smid P., CNC Programming Handbook, Industrial Press, 2005

Reference Books

1. Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018.
2. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
4. Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)
5. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMHWeb
6. Radhakrishnan P. and Subramanyan S., "CAD/CAM/CIM", Wiley Eastern Ltd., New AgeInternational Ltd., 1994.
7. Raouf, A. and Ben-Daya, M., Editors, "Flexible manufacturing systems: recent development", Elsevier Science, 1995.

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Robotic Programming -II
(Course No. C 405)

Designation of Course	**Robotic Programming -II**		
Teaching Scheme:	**Examination Scheme**		**Credits Allotted**
Theory: - ----	End Semester Examination		
Practical: 02 Hours/Week	Internal Assessment		
	Term Work	25 Marks	01
	Oral	25 Marks	
	Total	**50 Marks**	**01**

Course Prerequisites: -	1. C/C++ Programming 2. Python Programming 3. Robot fundamentals 4. VAL/VAL-II Robot Programming
Course Objectives: -	To provide knowledge about 1. Robot operating system 2 2. Robot Simulation Engines 3. Programming for path and motion planning
Course Outcomes: -	The students should be able to 1. To Understand the basic principles of Robotics programming and development. 2. To Learn Robot Simulation Engines 3. Design real world applications using available software. 4. Understand integration technologies and its applications 5. To Understand Mapping and SLAM 6. Identify problems in integrating the system / simulations / programming.

Course Contents

Unit-I	**Introduction to Robot Operating System 2 (RoS 2)**	**04 Hrs.**
Architectural overview of the Robot Operating System, Framework and setup with ROS2 environment, ROS2 workspace structure, essential command line utilities. ROS2 nodes, topics, services, parameters, actions and launch files.		
Unit-II	**Robot Simulation Engines**	**04 Hrs.**
Physics simulations of Robots with Gazebo, Mujoco and Pybullet C++/Python APIs. Programming nodes, topics, services, actions with C/C++/Python. Real time programming with ROS2.		
Unit-III	**Programming for Path Planning**	**04 Hrs.**
Intro to Path Planning and Navigation, Classic Path Planning, Number of classic path planning approaches that can be applied to low-dimensional robotic systems. Coding the BFS and algorithms in C++. Sample-Based and Probabilistic Path Planning and improvement using the classic approach. Programming in Move it framework.		
Unit-IV	**Programming for Motion Planning**	**04 Hrs.**
Use of EKF ROS package to a robot to estimate its pose. Monte Carlo Localization:- The Monte Carlo Localization algorithm which uses particle filters to estimate a robot's pose. Build MCL in C++ :- Coding the Monte Carlo Localization algorithm in C++. Simultaneous Localization and Mapping (SLAM) implementation with ROS2 packages and C++. Combining mapping algorithms with the localization concepts.		

Unit-V	Mapping and SLAM	04 Hrs.
Introduction to the Mapping and SLAM concepts and algorithms. Occupancy Grid Mapping:- Mapping an environment with the Occupancy Grid Mapping algorithm. Grid-based FastSLAM:- Simultaneous mapping an environment and localize a robot relative to the map with the Grid-based FastSLAM algorithm.		
Unit-VI	**Introduction to Microros**	**04 Hrs.**
Concepts of microros, Client library, featuresof microros, real time operating systems (RTOS- Free RTOS, Zephyr), implementation of microros on ARM/ESP32 based microcontrollers.		

Term Work:

Term work shall consist record of minimum 8 experiments from the following.

1. Study of Nodes and Robot Operating system 2 (ROS 2) topic
2. Study of Services, actions in Robot Operating system 2 (ROS 2)
3. Mujoco and Gazebo Simulations through (ROS 2) programming
4. Simulation of 6-dof manipulator through program in ROS2
5. Simulation of autonomous vehicle (Mobile and field robots) through program in ROS2
6. Microros implementation on ESP32
7. Microros implementation on STM32L4
8. Motion planning with Moveit2 Discovery kit IoT

Textbooks:

1. Programming Robots with ROS, Morgan Quigley, Brian Gerkey, & William D Smart, SPD Shroff Publishers and Distributors Pvt Ltd., 2016
2. S.K. Saha “Introduction to Robotics”, The McGraw Hills company.

References Books:

1. Learning ROS for Robotics Programming, Aaron Martinez, Enrique Fernandez, PACKT publishing, 2013
2. Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System, Lentin Joseph, PACKT publishing, 2015

INTERNSHIP

(Course No. C 407)

Designation of Course	**Internship**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - -- Hours/ Week	End Semester Examination	-- Marks	--
Tutorial: - --Hours/ Week	Internal Assessment	-- Marks	
Practical: - -- Hours/ Week	Term Work	25 Marks	03
	Oral/Practical	25 Marks	
	Total	**50 Marks**	**03**

Course Prerequisites: -	The students should have knowledge of 1. All courses up to B. Tech Semester VI.
Course Objectives: -	1. To expose technical student to the industrial environment. 2. To provide possible opportunities to learn, understand, and sharpen the real time technical, managerial skills required at the job. 3. To familiarize with various materials, processes, products and their applications along with relevant aspects of quality control. 4. To acquaint the social, economic, and administrative considerations that influence the working environment of industrial organization.
Course Outcomes: -	The students should be able to– 1. Understand the latest changes in technological world and apply fundamental principles of science and engineering. 2. Create ability to identify, formulate and model problems and apply it to find engineering solutions based on a system approach. 3. Understand importance of sustainability and cost-effectiveness in design and development of engineering solution. 4. Create ability to be multi skilled engineer with a good technical knowledge, management, leadership, entrepreneurship skills. 5. Create awareness of social, cultural, global, and environmental responsibility as an engineer. 6. Create ability to communicate efficiently.

Course Contents

Introduction:
Internships are educational and career development opportunities, providing practical experience in a field or discipline. Internships are far more important as the employers are looking for employees who are properly skilled and having awareness about industry environment, practices, and culture. Internship is structured, short-term, supervised training often focused on tasks or projects with defined time scales. Core objective is to expose technical students to the industrial environment, which cannot be simulated/experienced in the classroom and hence creating competent professionals in the industry and to understand the social, economic and administrative considerations that influence the working environment of industrial organizations. Engineering internships are intended to provide students with an opportunity to apply theoretical knowledge from academics to the realities of the field work/training.
Duration:
Internship to be completed after semester 6 and before commencement of semester 7 of at least 8 weeks (60 Days); and it is to be assessed and evaluated in semester 7.
Internship work Identification:
Student may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/NGO's/Government organizations/Micro/Small/Medium enterprises to make themselves ready for the industry.

Contacting various companies for Internship and Internship work identification process should be initiated in the 6th semester in coordination with training and placement cell/ industry institute cell/ internship cell. This will help students to start their internship work on time. Also, it will allow students to work in vacation period after their 6th semester examination. Student can take internship work in the form of Online/onsite work from any of the following but not limited to:

- Working for consultancy/ research project,
- Participation at Events (Technical / Business)/in innovation related completions like Hackathon,
- Contribution in Incubation/ Innovation/ Entrepreneurship Cell/ Institutional Innovation Council/ startups cells of institute
- Development of new product/ Business Plan/ registration of start-up,
- Participation in IPR workshop/Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos,
- Industry / Government Organization Internship, Internship through Internshala,
- In-house product development, intercollegiate, inter department research internship under research lab/group,
- micro/small/medium enterprise/online internship.

[1] https://www.aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf

Internship Diary/ Internship Workbook:

Students must maintain Internship Diary/ Internship Workbook. The main purpose of maintaining diary/workbook is to cultivate the habit of documenting. The students should record in the daily training diary the day-to-day account of the observations, impressions, information gathered, and suggestions given, if any. The training diary/workbook should be signed after every day by the supervisor/ in-charge of the section where the student has been working. Internship Diary/workbook and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.

Internship Diary/workbook may be evaluated based on the following criteria:

• Proper and timely documented entries • Adequacy & quality of information recorded. • Data recorded. • Thought process and recording techniques used. • Organization of the information

Internship Work Evaluation:

The evaluation of these activities will be done by Cell In-charge/faculty mentor or Industry Supervisor based on Overall compilation of internship activities, evidence needed to assign the points and the duration for certain activities. Assessment and Evaluation is to be done in consultation with internship supervisor (Internal and External – a supervisor from place of internship.

Recommended evaluation parameters-Post Internship Internal Evaluation -25 Marks + Internship Diary/Workbook and Internship Report - 25 Marks

Evaluation through Seminar Presentation/Viva-Voce at the Institute

The student will give a seminar based on his training report, before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria:

• Depth of knowledge and skills Communication & Presentation Skills • Teamwork • Creativity • Planning & Organizational skills • Adaptability • Analytical Skills • Attitude & Behavior at work • Societal Understanding • Ethics • Regularity and punctuality • Attendance record • Logbook • Student's Feedback from External Internship Supervisor.

After completion of Internship, the student should prepare a comprehensive report to indicate what he/she has observed and learnt in the training period. The student may contact Industrial Supervisor/

Faculty Mentor for assigning special topics and problems and should prepare the final report on the student's presence physically, if the student is found absent without prior intimation to the department/institute/concern authority, entire training can be cancelled.

The report shall be presented covering following recommended fields but not limited to,

• Title/Cover Page • Internship completion certificate • Internship Place Details- Company background-organization and activities/Scope and object of the study / personal observations • Index/Table of Contents • Introduction • Title/Problem statement/objectives • Motivation/Scope and rationale of the study • Methodological details • Results / Analysis /inferences and conclusion • Suggestions / Recommendations for improvement to industry, if any • Attendance Record • Acknowledgement • List of reference (Library books, magazines and other sources)

Feedback from internship supervisor (External and Internal)

Post internship, faculty coordinator should collect feedback about student with following recommended parameters: Technical knowledge, Discipline, Punctuality, Commitment, Willingness to do the work, Communication skill, individual work, Teamwork, Leadership, etc.

PROJECT STAGE -I

(Course No. C 406)

Designation of Course	**Project Stage -I**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - -- Hours/ Week	End Semester Examination	-- Marks	--
Tutorial: - --Hours/ Week	Internal Assessment	-- Marks	
Practical: - 02 Hours/ Week	Term Work	50 Marks	03
	Oral/Practical	50 Marks	
	Total	**100 Marks**	**03**

Course Prerequisites: -	The students should have knowledge of 1. Knowledge of basic concepts in Robot Programing. 2. Basic information of fundamentals of robotics. 3. Basic knowledge of Data Structures and Algorithm. 4. Knowledge of basic concepts in Robotics & Automation Engineering. 5. Basic knowledge of robot design.
Course Objectives: -	1. To identify problem for a specific need of an organization 2. To review literature on specific research topic 3. To make feasible, sustainable design 4. To work sincerely as a member of a team 5. To communicate ideas to supervisors as well as subordinates 6. To develop new equipment or make modifications in existing one

Course Contents

Details of Project Stage -I

1. The formation of a project team with members having similar interest.
2. Discuss the ideas within the team members and choosing a faculty member interested in similar activity with the consent of the HOD. The projects can be on new equipment development, on industry sponsored problems or on research-oriented subjects.
3. Discuss the project with the faculty with the idea that projects selected are suitable for design and fabrication with the available resources.
4. First stage presentation with
    - Project Aim
    - Feasible design and alternatives considered.
    - Estimation of approximate cost of the project
    - Activities bar chart
    - Internal Lab resources required.
    - External resources required and their availability.
5. Second presentation with
    - Collection of reference material and
    - Design of the equipment with working drawings
    - Stage of work completed through activities bar chart.
6. Third presentation of complete work with suggested modifications.

TOTALLY INTEGRATED AUTOMATION

(Course No. 408)

Designation of Course	**Totally Integrated Automation**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours / Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**05**

Course Prerequisites: -	The students should have knowledge of 1. Knowledge of Signals and Systems, Instrumentation for Robotics & Automation 2. Knowledge of Basics of Sensors, PLC & HMI, Future Factory (FMS) 3. Knowledge of Digital Electronics, Automatic Control Systems and computer networking
Course Objectives: -	To impart knowledge on 1. Various automation needs of the industries. 2. Fundamental concepts of SCADA Systems 3. The utility of Distributed Control Systems and applications of DCS in Process Automation 4. Fundamentals of PAC 5. Concepts of HMI and SCADA 6. To gain knowledge in communication protocols in an integrated system
Course Outcomes: -	At the end of this course, students will demonstrate the ability to – 1. Outline the selection, and application of various TIA control elements 2. Discuss the configuration of SCADA functionalities with Tags, Screens, and Trends 3. Compare various communication protocols for automation system 4. Identify and differentiate various sub systems of DCS 5. Describe various functions of Interfaces in DCS. 6. Analyze and design an appropriate system for the industrial applications.

Course Contents

Unit I	**Introduction to Totally Integrated Automation (TIA)**	**(08 Hrs.)**
Need, components of TIA systems, advantages, Programmable Automation Controllers (PAC), Vertical Integration structure. Necessity and Role in Industrial Automation, Need for HMI systems. Types of HMI.		
Unit II	**Supervisory Control and Data Acquisition (SCADA)**	**(08 Hrs.)**
Overview Developer and runtime packages, architecture, Tools, Tag, Internal & External graphics, Alarm logging, Tag logging, structured tags, Trends, history, Report generation, SCADA industrial applications and other sector viz; defence, agriculture and medical.		
Unit III	**Communication Protocols of SCADA**	**(08 Hrs.)**
Proprietary and open Protocols, OLE/OPC, DDE, Server/Client Configuration, Messaging, Recipe, User administration, Interfacing of SCADA with PLC, drive, and other field device.		
Unit IV	**Distributed Control Systems (DCS)**	**(08 Hrs.)**
Introduction : DCS Evolution, DCS Architecture, Comparison, Local Control unit, Process Interfacing Issues, Redundancy concept, Communication facilities, Case studies of Machine automation, Process automation, Comparison between SCADA and DCS.		

Unit V	Interfaces in DCS	(08 Hrs.)
Operator interfaces: low level, high level, Operator Displays, Engineering Interfaces: Low level, high level, General purpose computers in DCS, Interfacing between two industrial grade equipment's through PLC.		
Unit VI	**Industrial Plant Design**	**(08 Hrs.)**
Design criteria, Process sequencing, Plant layout modelling, Selection of industrial power and automation cables, Overview of plant simulation software. **Totally Integrated Automation in Digital Enterprise**- Automated engineering, Intelligent data management, Virtual commissioning, Cloud-based engineering, Preventive maintenance, Individualized mass production, Integrated energy management.		

Term Work

(Term work shall consists of minimum 8 experiments based on above syllabus)

Hands-on Experiments related to Course Contents in Totally Integrated Automation

1. Study of conveyor automation system using PLC, SCADA and Electrical drive.
2. Design of inspection automation system using sensors, PLC, HMI/SCADA.
3. Sizing and Selection of industrial power and automation cable for a typical application.
4. Design of simple water management system using PLC, SCADA and Electrical drive.
5. Design and Simulation of process automation using simulation software Viz. AUTOMATION STUDIO/ CIROS
6. Design and Simulation of robotic system using simulation software Viz. AUTOMATION STUDIO/ CIROS
7. Study of integration of robotics system with CNC Machine
8. Study of SIMATIC S7-1500, S7-1200, HMI PANEL and software SIMATIC STEP 7 based on TIA portal of Siemens.
9. Graphic image creation for operator control and monitoring
10. To prepare graphic object dynamic through programming for real time monitoring with an HMI
11. Troubleshooting and alarms with an HMI device
12. Industrial visit to automation industry
13. Interfacing between two industrial grade equipment's through PLC

Project Based Learning

Students have to prepare and submit a demonstration models/charts based on above syllabus
Following are the list of project-based learning (Not limited to)

1. To prepare a demonstration model/chart based on totally integrated automation.
2. To prepare a demonstration model/chart based on SCADA System.
3. To prepare a demonstration model/chart based on Communication system for SCADA
4. To prepare a demonstration model/chart based on DCS
5. To prepare a demonstration model/chart based on interfaces in DCS
6. To prepare a demonstration model/chart based on Industrial Plant Design

Text books

1. Kelly, John. W. Webb & Ronald A. Reis, "Programmable logic controllers: Principles and Applications", Prentice Hall India, 2003.
2. Michael P. Lukas, Distributed Control systems, Van Nostrand Reinfold Company1995
3. David Bailey, Edwin Bright, "Practical SCADA for industry", Newnes, Burlington, 2003.
4. Gordon Clarke, Deon Reyneders, Edwin Wright, "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related systems", Newnes Publishing, 2004.

5. Win C C Software Manual, Siemens, 2003
6. RS VIEW 32 Software Manual, Allen Bradly, 2005
7. CIMPLICITY SCADA Packages Manual, Fanuc India Ltd, 2004
8. William T Shaw, "Cybersecurity for SCADA systems", PennWell, 2006.
9. Stuart G McCrady, "Designing SCADA Application Software", Elsevier, 2013.

Reference Books

1. SIMATIC STEP 7 in the Totally Integrated Automation Portal", SIEMENS AG, 2012.
2. P.A. Janaki Raman, Robotics and Image Processing an Introduction, Tata McGraw Hill Publishing company Ltd., 1995.
3. Stuart A Boyer: SCADA supervisory control and data acquisition, International Society of Automation, 2010.
4. "Anatomy of Automation"- Amber G.H & P. S. Amber, Prentice Hall. Principles of CIM by Vajpayee, PHI.

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

El-II INDUSTRIAL PRODUCT DESIGN

(Course No. 409.1)

Designation of Course	**Industrial Product Design**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical : 02 Hours/ Week	Internal Evaluation	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**04**

Course Prerequisites:-	Student should have Basic Knowledge of 1. Machine Drawing I & II 2. Industrial Engineering & Management, Manufacturing Process, Advanced Manufacturing Processes 3. CAD software viz. CATIA/ ProE/ SolidWorks/ Uni-Graphics
Course Objectives:-	To study 1. Various aspects of product design and development different product design methods. 2. Concept generation and product specification. 3. Industrial Design and Prototyping. 4. Aesthetic, Environment and Ergonomic considerations to develop an industrial product.
Course Outcomes:-	Students should be able to 1. Understand fundamental concept of industrial product design 2. Understand and apply different product design methods 3. Understand the concept generation and develop the product specifications 4. Evaluate legal economic issues and select a prototyping method for industrial product 5. Evaluate the approaches of Aesthetic, Ergonomics and safety in industrial product 6. Understand design for manufacturing, assembly and environment and apply for industrial product

Course Contents

Unit 1	**Introduction to Product Design and Development**	**(6 Hrs)**
Overview of industrial design, Successful product, development of quality aspect of product design; Challenges of product development, Market survey. Identify customer needs and product planning processes. Product architecture: Implication of architecture, establishing the architecture, related system level design issue.		
Unit 2	**Product Design Methods**	**(6 Hrs)**
Creative and rational, clarifying objectives - the objective tree method, establishing functions- the function analysis method, setting requirements–the performance specification method, determining characteristics–the QFD method, generating alternatives – morphological chart method, evaluating alternatives – the weighted objective method, improving details – the value engineering method and design strategies.		
Unit 3	**Product Specifications and Concept Generation**	**(6 Hrs)**
Concept generation, five step concept generation method, concept selection, concept screening, concept testing, Product specification, steps to establish the target specifications.		

Unit 4	Industrial Design and Prototyping	(6 Hrs)
Its need, impact and quality, industrial design process and its management, legal issues in product design, IPR, design resources, economics and management of product development projects. Prototyping: Basics and principles of prototyping, Rapid prototyping technologies, planning for prototypes		
Unit 5	**Aesthetics, Ergonomics and Industrial Safety**	**(6 Hrs)**
Introduction-General approach to the man-machine relationship-workstation design working position and posture. An approach to industrial design - elements of design structure for industrial design in engineering applications in manufacturing systems. Environmental Application of ergonomics in industry for safety, health and environment control. Safety and ISO 14000 Systems		
Unit 6	**Design for Manufacture, Assembly and Environment**	**(6 Hrs)**
Estimating manufacturing cost, reducing component, assembly and support costs, design for assembly, design for disassembly, design for environment, design for graphics and packaging, effective prototyping-principle and planning. Product data management. Innovation and creativity in product design. Product costing, value engineering, aesthetic concepts.		

Project Based Learning:

1. Live market survey with at least 100 customer for given product.
2. To develop 2D or 3D model of product architecture for selected product.
3. To develop 2D or 3D model by using any prototyping method.
4. Write the patent for given model and file the same.

Term Work: Use of different CAD software *viz.* CATIA/ ProE/ SolidWorks/ Uni-Graphics while doingfollowing case studies:

1. A case study on market study to identify costumer needs
2. A case study on use of morphological analysis
3. A case study on Quality Function Development (QFD)
4. A case study of one aesthetic considerations in product design
5. Failure Modes and Effects Analysis (FMEA) in product design
6. A case study on Design for Manufacturing
7. A case study on Product Lifecycle Management (PLM)
8. A case study of one ergonomic considerations in product design
9. A case study of one industrial safety considerations in product design

Text Books:

1. Product Design and Development: Karl T. Ulrich, Steven G. Eppinger; Irwin McGraw Hill
2. Product design and Manufacture: A.C. Chitale and R.C. Gupta; PHI Chitale & Gupta, "ProductDevelopment", Tata McGraw Hill
3. New Product Development: Tim Jones, Butterworth, Heinemann, Oxford, 1997.
4. Product Design for Manufacture and Assembly: Geoffrey Boothroyd, Peter Dewhurst and WinstonKnight.

Reference Books:

1. Product Design: Otto and Wood; Pearson education.
2. Industrial Design for Engineers: Mayall W.H, London, Hiffee books Ltd, 1988
3. Introduction to ergonomics – R.C. Bridger, McGraw Hill Pub.
4. Product Design – Kevin Otto, Kristin Wood Pierson Education.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

El-II PROJECT MANAGEMENT & ETHICS

(Course No. 409.2)

Designation of Course	**Project Management & Ethics**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**04**

Course Prerequisites: -	The students should have knowledge of 1. Mathematics & Statistics 2. Industrial engineering & management 3. Soft skills and professional skills
Course Objectives: -	1. To create awareness about the concepts of project management and its components 2. To apply the techniques specified by project management body of knowledge for effective project management. 3. To create awareness of social and professional responsibility among stakeholders
Course Outcomes: -	The students should be able to– 1. Understand concepts of project management and apply it to various phases in project life cycle 2. Understand economic models, evaluate project profitability and analyze risk management 3. Understand different cost estimating & forecasting methods to apply in project budgeting 4. Understand the methods of project planning, scheduling and apply it to reduce project duration 5. Understand the project execution, monitoring, control process and evaluate the performance of the project 6. Understand professional ethics of project management and apply it for organizational benefits

Course Contents

Unit I	**Introduction To Project Management**	**(06 Hrs.)**
Project, Project Management, Management by projects, Project Management Associations, Benefits of Project Management, Project management Process, Role of Project Manager, Project Lifecycle		
Unit II	**Project Management Techniques and Risk Management**	**(06 Hrs.)**
Feasibility Studies, Numerical Models (Payback Period, Return on Investment, Net Present Value, Internal rate of Return), Scoring Models, Break Even Analysis, Project Risk Management: Introduction, Risk, Risk Management, Role of Risk Management in Overall Project Management, Steps in Risk Management, Risk Identification, Risk Analysis, Reducing Risks.		
Unit III	**Project Cost Estimating**	**(06 Hrs.)**
Estimating terminology, Project Costs, Estimating Methods (Jobbing, Factoring, Inflation, Economies of Sales, Unit Rates, Day Work), Analogous Estimating, Parametric Estimating, Bottom-Up Estimating, Three-Point Estimates, Monte Carlo Simulation, Project Budgeting, Resource Allocation, Cost Forecasts.		
Unit IV	**Project Planning and Scheduling**	**(06 Hrs.)**
Project Planning: Introduction, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS), Scheduling:		

Introduction, Development of Project Network, Time Estimation, Determination of the Critical Path, PERT Model, Measures of variability, CPM Model, Network Cost System.		
Unit V	**Project Monitoring and Control**	**(06 Hrs.)**
Project Execution and Control: Introduction, Project Execution, Project Control Process, Purpose of Project Execution and Control, Project Management Information System: Introduction, Project Management Information System (PMIS), Planning of PMIS, Design of PMIS, Project Performance Measurement and Evaluation: Introduction, Performance Measurement, Productivity, Project Performance Evaluation, Benefits and Challenges of Performance Measurement and Evaluation, Controlling the Projects		
Unit VI	**Professional Responsibility (Ethics)**	**(06 Hrs.)**
Ensuring Integrity and Professionalism, Project Management Knowledge Base, Enhancing Individual Competence, Balancing Stakeholder Interests, Interactions with Team Members and Stakeholders, Templates, Tools and Techniques		

Term Work

1. Identify the Key Components of a Project
2. Create a Project with MS Project
3. Represent Project Resources in MS Project
4. Perform Resource Leveling in MS Project
5. Plan and manage procurement
6. Plan and manage schedule
7. Develop, execute, and validate a strategy for stakeholder engagement
8. Determine risk management options
9. Displaying Calendar Information in a Gantt Chart

Project Based Learning

1. Case study involving various aspects of project
2. Case study involving various techniques used for project selection.
3. Case study of project cost estimation
4. Case study based on project scheduling
5. Industrial case study of project ethics
6. Case study on project risk management

Textbooks

1. Erik Larson, Clifford Gray; “Project Management: The Managerial Process”; McGraw Hill Education; Sixth edition (1 July 2014)
2. Panneerselvam R; “Project Management”; Prentice Hall India Learning Private Limited; 1 Edition (2009)
3. Samuel J. Mantel, Jack R. Meredith; “Project Management: A Managerial Approach”; Wiley; Eighth edition (6 August 2012)
4. Gupta R; “Project Management”; Prentice Hall India Learning Private Limited; Second edition (2014)

Reference Books

1. Project Management Institute; “A Guide to the Project Management Body of Knowledge (PMBOK Guide)”; 5th Revised edition (1 January 2013)
2. Harold Kerzner; “Project Management: A Systems Approach to Planning, Scheduling and Controlling Paperback”; Wiley; tenth edition (20 November 2012)

Unit Tests

Unit Test-I	Unit- I,II, III
Unit Test-II	Unit- IV, V, VI

El-II ADDITIVE MANUFACTURING & RAPID PROTOTYPING

(Course No. 409.3)

Designation of Course	**EL II: Additive Manufacturing & Rapid Prototyping**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**04**

Course Prerequisites: -	The students should have knowledge of 1) Solid Modelling, Auto CAD 2) Manufacturing Technology I & II 3) Design & Analysis of Machine Components
Course Objectives: -	1) To understand the fundamental concepts of Additive Manufacturing (i.e., Rapid Prototyping) and 3-D printing, its advantages, and limitations. 2) To classify various types of Additive Manufacturing Processes and know their working principle, advantages, limitations etc. 3) To have a holistic view of various applications of these technologies in relevant fields such as mechanical, Bio-medical, Aerospace, Electronics etc.
Course Outcomes: -	The students should be able to– 1. Understand the importance of additive manufacturing process and AM process chain 2. Understand and apply Liquid-based and Solid Based additive manufacturing processes. 3. Understand and apply powder based additive manufacturing processes. 4. Understand and apply various Metal Additive Manufacturing process for different products 5. Apply various AM data formatting and data processing techniques for different products 6. Select suitable material for AM process and explore different applications of AM parts from various fields like Automobile, Aerospace, Bio-medical etc.

Course Contents

Unit I	**Introduction to Rapid Prototyping**	**(06 Hrs.)**
Introduction: Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, Commonly used Terms, Classification of RP process, AM process chain: Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build , removal and clean up, post processing.		
Unit II	**Liquid-based and Solid Based Rapid Prototyping**	**(06 Hrs.)**
Liquid-based Rapid Prototyping Systems: Stereo lithography Apparatus (SLA), Solid ground curing (SGC). Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. **Solid-based Rapid Prototyping Systems:** Laminated Object Manufacturing (LOM), Fused Deposition Modeling (FDM), Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.		

Unit III	Powder Based Rapid Prototyping	(06 Hrs.)
Powder Bed Fusion AM Processes: Selective laser Sintering (SLS), Materials, Indirect and direct SLS, Powder fusion mechanism and powder handling, Process Modelling, SLS Metal and ceramic part creation, post processing, post curing, surface deviation and accuracy, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes, Post processing of AM parts **Laser Engineered Net Shaping (LENS):** Processes, materials, products, advantages, limitations, and applications– Case Studies.		
Unit IV	**Design for Additive Manufacturing**	**(06 Hrs.)**
Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc. **Guidelines for process selection**: Introduction, selection methods for a part, challenges of selection, example system for preliminary selection, production planning and control		
Unit V	**AM Data Formatting and Data Processing**	**(06 Hrs.)**
Rapid Prototyping Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Rapid Prototyping Software's: Features of various RP software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor. AM Data Processing: Part Orientation and Support Structure Generation, Model Slicing and Contour Data Organization, Direct and Adaptive Slicing, Hatching Strategies and Tool Path Generation.		
Unit VI	**AM Materials and Applications**	**(06 Hrs.)**
3D Printing Materials: properties, characteristics, and application of all types (ABS, PLA, PVA, HDPE, PET, PETG etc.) Types of Composites Materials, properties, characteristics, and application of all types. (N6, N12, ABS Carbon Fiber, etc.) RP Applications: Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules.		

Term Work

1. Study of 3D Printing Machines
2. Study of different AM Software's
3. Study of AM Data Formatting and Data Processing
4. Study and demonstration of Plastic 3D Printing using FDM based Rapid Prototyping (Plastic & Composites)
5. Study and demonstration of Plastic 3D Printing using SLS based Rapid Prototyping (Plastic & Composites)
6. Study and demonstration of Plastic 3D Printing using Liquid based/solid based/powder based Rapid Prototyping (Plastic & Composites)
7. Study and demonstration of Plastic 3D using FDM based Rapid Prototyping Printing (Metals)
8. Assignment on 3D Printing Applications.
9. Select appropriate 3D printing material and justify it for following application: -
   a. Prototyping
   b. medical appliances
   c. Construction.

10. Selection of 3d printing machine specification for following materials: -
    a. Polymers
    b. Composites
    c. Metals
11. To measure surface quality and mechanical properties of AM product
12. Study of CAM packages for AM

Project Based Learning

Students have to prepare and submit a demonstration models based on above syllabus (Not limited to)

1. To prepare a demonstration model/chart of AM Processes chain
2. To prepare a demonstration model of liquid-based AM technologies
3. To prepare a demonstration model of solid based AM technologies
4. To prepare a demonstration model of powder-based AM technologies
5. To prepare a 3D printed model for various applications (Bio-medical, aerospace etc.)
6. To prepare a document on data formatting and data process by selecting one application

Textbooks

1. Ali K. Kamrani, Emand Abouel Nasr, "Rapid Prototyping: Theory and Practice", Springer, 2006.
2. Anupam Saxena, Birendra Sahay, "Computer Aided Engineering Design", Springer, 2005.
3. Patri K. Venuvinod and Weiyin Ma, "Rapid Prototyping: Laser-based and Other Technologies", Springer, 2004.
4. Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles & Applications", 4th Edition, World Scientific, 2015.
5. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.
6. Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.

Reference Books

1. Chua Chee Kai, Leong Kah Fai, "Rapid Prototyping: Principles and Applications", World scientific, 2003.
2. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
3. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.
4. David F. Rogers, J. A. Adams, "Mathematical Elements for Computer Graphics", TMH, 2008.
5. Kevin N. Otto, Kristin L. Wood, "Product Design", Pearson Education, 2004.

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

El-II IMAGE PROCESSING

(Course No. 409.4)

Designation of Course	**Image Processing**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**04**

Course Prerequisites: -	Engineering Graphics, Python programming, AI
Course Objective: -	The students will learn about the basics of image processing in this course
Course Outcomes	Students shall be able to 1. Understand the fundamentals of digital image processing 2. Understand the basics of image enhancement and apply the knowledge in spatial domain. 3. Understand the basics of image enhancement and apply the knowledge in Frequency domain. 4. Apply knowledge of image restoration 5. Apply knowledge of morphing and colour processing to an image 6. Understand Image Compression and Application of IP

Course Contents

Unit I	**Digital Image Fundamentals**	**(06 Hrs.)**
What is Digital Image Processing, Origins of Digital Image Processing, Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition.		
Unit II	**Image Enhancement in the Spatial Domain**	**(06 Hrs.)**
Image Sampling and Quantization, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations. Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters		
Unit III	**Frequency Domain**	**(06 Hrs.)**
Preliminary Concepts, The Discrete Fourier Transform (DFT) of Two Variables, Properties of the 2-DDFT, Filtering in the Frequency Domain, Image Smoothing and Image Sharpening Using Frequency Domain Filters, Selective Filtering		
Unit IV	**Restoration:**	**(06 Hrs.)**
Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Linear, Position-Invariant degradations Estimating the		

Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering		
Unit V	**Morphological Image Processing**	**(06 Hrs.)**
Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing. Image Processing: Color Fundamentals, Color Models, Pseudo color Image Processing.		
Unit VI	**Image Compression and Application of IP**	**(06 Hrs.)**
Image Compression: Fundamentals, Models, Error Free and lossy compressions, Standards Applications of IP: satellite, sonar, radar and medical uses		

Term work

1. Image Printing Program Based on Half toning.
2. Reducing the Number of Intensity Levels in an Image.
3. Zooming and Shrinking Images by Pixel Replication.
4. Zooming and Shrinking Images by Bilinear Interpolation.
5. Arithmetic Operations.
6. Image Enhancement Using Intensity Transformations.
7. Histogram Equalization.
8. Spatial Filtering.
9. Enhancement Using the Laplacian.
10. Unsharp Masking

Text Books:

1. Digital Image Processing by Bhabatosh Chanda and Dwijesh Majumder, PHI
2. Fundamentals of Digital Image Processing by Anil K Jain, PHI
3. Digital Image Processing Using Matlab, Rafel C. Gonzalez and Richard E. Woods, Pearson Education.

Reference Books:

1. Kenneth R. Castleman, Digital Image Processing‘, Pearson, 2006.
2. D,E. Dudgeon and RM. Mersereau, Multidimensional Digital Signal Processing‘, Prentice Hall Professional Technical Reference, 1990.
3. William K. Pratt, Digital Image Processing‘, John Wiley, New York, 2002

Project based learning

Projects related to

1. Image Printing Program Based on Halftoning.
2. Reducing the Number of Intensity Levels in an Image.
3. Zooming and Shrinking Images by Pixel Replication.
4. Zooming and Shrinking Images by Bilinear Interpolation.
5. Arithmetic Operations.
6. Image Enhancement Using Intensity Transformations.
7. Histogram Equalization.
8. Spatial Filtering.
9. Enhancement Using the Laplacian.
10. Unsharp Masking

INDUSTRIAL ENGINEERING & MANAGEMENT

(Course No. 410)

Designation of Course	**Industrial Engineering & Management**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
	Internal Assessment	40 Marks	
	Total	**100 Marks**	**03**

Course Prerequisites: -	The students should have knowledge of 1. Fundamentals of Mechanical Engineering 2. Manufacturing Process 3. Advanced Manufacturing Processes
Course Objectives: -	To impart knowledge on 1. The fundamentals of management 2. Types of business organization and its structure 3. Fundamentals of main four departments of an organization i.e. finance, production, marketing and personnel 4. Details of method study tool of industrial engineering 5. Details of work measurement tool of industrial engineering 6. Details of ergonomics and industrial safety tool of industrial engineering
Course Outcomes: -	At the end of this course, students will demonstrate the ability to – 1. **Understand** fundamentals of management 2. **Understand** and select different types of business organizations and it's structure 3. **Evaluate** fundamentals of main four departments of an organization i.e. finance, production, marketing and personnel 4. **Understand** and **Analyze** the details of method study tool used in industrial engineering 5. **Understand** and **Analyze** the details of work measurement tool used in industrial engineering 6. **Understand** and **Analyze** the details of ergonomics and industrial safety tool used in industrial engineering

Course Contents

Unit I	**Management-An Introduction**	**(08 Hrs.)**
Management- Meaning and Definitions, Management, Administration, and Organization concepts, Management as an Art and Science and a profession, contribution of various thinkers to management thought, Types and Functions of Management. Different approaches to management – scientific, operational, human and system approach		
Unit II	**Organization**	**(08 Hrs.)**
Different forms of business Organization – Individual proprietorship, Partnership, Joint stock company, Co-Operative enterprise, Public Sector, Undertakings, organizational structures in Industries, Line, Functional, Line and functional, Project, Matrix Organization and Committees		
Unit III	**Financial, Marketing and Personnel Management**	**(08 Hrs.)**
Personnel Management-Definitions Recruitment, Selection and training of the employees, Job valuation and Merit rating, wage administration different methods of wage payments, incentives. Marketing Management-Definitions, Marketing and Selling concept, market segmentation, distribution channels, Market Research, Advertising and sales promotion and Sales forecasting. Financial Management-Capital structure, Fixed capital, working capital, sources of finance, cost analysis, Break even analysis, Depreciation and Financial statement.		

Unit IV	Method Study	(08 Hrs.)
Steps in method study, tools and techniques used, process chart symbols, flow diagrams, two handed chart, multiple activity chart, use of motion pictures and its analysis. SIMO charts, chorno & cycle graph, developing, presentation, installation and maintenance of improved methods.		
Unit V	**Work Measurement**	**(08 Hrs.)**
Time Study: Aim and objectives , terminology and tools, use of stop watch procedure in making a time study, elements, selection of operations time study forms, handling of foreign elements. Performance rating. **Allowances**: Personal, Fatigue and other allowances. Analysis and calculation of Standard Time. Determination of number of cycle's time study for indirect functions such as Maintenance, Marketing etc., MOST Technique. **Works Sampling**: Definition, Objectives, theory of Work Sampling. Other applications of work sampling, errors in work sampling study. **Synthetic and Standard data Methods**: Concepts, introduction to PMTS, MTM-1, WF, Basic motion time, MTM-2, and other second – generation methods timing of group operations		
Unit VI	**Ergonomics and Industrial Safety**	**(08 Hrs.)**
Definitions, importance in industry, basic anatomy of human body, anthropometrics, measurement of physical work and its techniques, work and rest cycles, bio mechanical factors environment effects. Importance of safety, planning, training, safety precautions, safety Equipment's, Government regulations on safety.		

Project Based Learning

Students have to prepare and submit a demonstration models/charts based on above syllabus
Following are the list of project-based learning (Not limited to)

1. Management: Types, Functions, Principles
2. Study of organization Structure
3. Study of Business organizations
4. Study of Financial, Marketing and Management
5. Study of Personnel Management
6. Study of Method Study methods and procedure
7. Study of Method Study charts
8. Study of Work Measurement methods and procedure
9. Study of Time study procedure and problems
10. Study of Work sampling and problems
11. Study of Ergonomics
12. Study of Industrial Safety

Text Books:

1. O. P. Khanna, Industrial Engineering & Management, Dhanapat Rai & Sons.
2. M. C. Shukla, Business Organization and Management, S. Chand & Co. Ltd, New Delhi.
3. Harold Koontz & Heinz Enrich, Essentials of Management, McGraw Hill International.
4. M. N. Mishra, Organizational Behavior, Vikas publishing New Delhi.
5. Dale Yoder, Personnel Management.
6. Work Study, ILO.

Reference Books:

1. S. S. Patil, Industrial Engineering & Management, Electro tech Publication.
2. Mansoor Ali &Dalela, Industrial Engineering & Management System, Standard Publisher distributions.

3. R. M. Currie, Work Study, ELBS.
4. Management by James A. F. Stoner, R. Edward Freeman, PHI
5. Management Today: Principles and Practice by Gene Burton and Manab Thakur, TMH
6. Organizational Behavior by Keith Davis, TMH
7. Management (Tasks, responsibilities and Practices) by Peter Drucker, Harper Business
8. Production Management by Lockyer, ELBS
9. Modern Production Management by E. S. Buffa (John Wiley)
10. Financial Management by Vanhorne, PHI
11. Financial Management (Theory and Practice) by Prasanna Chandra, TMH
12. Marketing Management by Philip Kotler, Pearson Edition
13. Marketing Management by Rajan Saxena, TMH
14. Personnel Management by Edward Flippo, TMH
15. Industrial Engineering and PPC" by A.K Bewwor and V.A.Kulkarni.

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

FIELD & SERVICE ROBOTS

(Course No. 411)

Designation of Course	**Field & Service Robots**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial: - 01 Hours/ Week	Internal Assessment	40 Marks	
	Tutorial		01
	Total	**100 Marks**	**04**

Course Prerequisites: -	The students should have knowledge of 1. Sensor technology 2. Artificial Intelligence for robotics 3. Robot programming
Course Objectives: -	To impart knowledge on 1. The applications and current trend in field and service robot (FSR) 2. Path planning algorithms inside a field/service robot for navigation 3. Interaction interface concepts for humanoid robot
Course Outcomes: -	The students should be able to– 1. Describe the applications and current trend in field and service robot 2. Explain about the kinematic modeling of mobile robots 3. Identify, formulate and solve algorithm related to localization, obstacle avoidance, and mapping 4. Apply and program robot for reactive concepts for robot interaction with human, between machines and among robots 5. Analyze the concepts of balancing legged robots and interaction interface concepts for humanoid robot 6. Implement path planning algorithms inside a field/service robot for navigation.

Course Contents

Unit I	**Introduction**	**(08 Hrs.)**
History of service robotics, Present status and future trends, Need for service robots, applications examples and Specifications of service and field Robots. Non-conventional Industrial robots.		
Unit II	**Localization**	**(08 Hrs.)**
Introduction-Challenges of Localization, Map Representation, Probabilistic Map based Localization, Monte Carlo localization, Landmark based navigation, Globally unique localization, Positioning beacon systems, Route based localization.		
Unit III	**Planning and Navigation**	**(08 Hrs.)**
Introduction-Path planning overview, Road map path planning, Cell decomposition path planning, Potential field path planning, Obstacle avoidance, Case studies: Tiered robot architectures.		
Unit IV	**Field Robots**	**(08 Hrs.)**
Ariel robots, Collision avoidance, Robots for agriculture, mining, exploration, underwater, Civilian and military applications, Nuclear applications, Space applications.		
Unit V	**Humanoids**	**(08 Hrs.)**
Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration.		
Unit VI	**Human Recognition and Application of FSR**	**(08 Hrs.)**

Image Human activity recognition using vision, touch, sound, Vision, Tactile Sensing, Models of emotion and motivation. Performance, Interaction, Safety and robustness, Applications - Case studies.

Project Based Learning

1. Need for service robot.
2. Experiment on robot kinematics.
3. Probabilistic Map based Localization-Monte carlo localization
4. Global & Local path planning in robotics.
5. Assignment on Metrical maps - Grid maps - Sector maps – Hybrid Maps.
6. Case study on Human activity recognition using vision, touch, sound etc.
7. Use of PUDU Bot mobile robot for office work.

Text books

1. Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, "Field and Service Robotics ", Springer, 2011.
2. Sebastian Thrun, Wolfram Burgard, Dieter Fox, “Probabilistic Robotics”, MIT Press, 2005.
3. Karsten Berns, Ewald Von Puttkamer, “Autonomous L and Vehicles Steps towards Service Robots”, Vieweg Teubner Springer, 2009.
4. Bruno Siciliano, Oussama Khatib, Springer Hand book of Robotics, Springer, 2008.

Reference Books

1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, „Introduction to Autonomous Mobile Robots‖, Bradford Company Scituate, USA, 2004
2. Riadh Siaer, „The future of Humanoid Robots- Research and applications‟, Intech Publications, 2012.
3. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.
4. Howie Choset, Kevin Lynch Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, “Principles of Robot Motion-Theory, Algorithms, and Implementation”, MIT Press, Cambridge, 2005.

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

MOBILE ROBOTS & DRONE TECHNOLOGY

(Course No. 412)

Designation of Course	**Mobile Robots & Drone Technology**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory ------ Hours/ Week	End Semester Examination	---	---
Practical: - 02 Hours/ Week	Internal Assessment	---	
	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**50 Marks**	**01**

Course Prerequisites: -	The students should have knowledge of 1. Robotics Simulation softwares 2. Robotic Control Systems 3. Artificial Intelligence in Robotics.
Course Objectives: -	1. To recognize and describe the role of Mobile Robots & Drone Technology (MRDT) in past, present, and future society. 2. To comprehend and explain various components of MRDT. 3. To comprehend and explain basics of flight and flight control systems. 4. To understand and describe basics of underwater robots.
Course Outcomes: -	The students should be able to– 1. Understand the challenges in developing autonomous mobile Robots. 2. Abstract kinematic control of wheeled mobile Robots. 3. Understand the challenges involved in sensory perception for mobile Robots. 4. Ability to design UAV drone system. 5. To understand working of different types of engines and its area of applications. 6. To understand static and dynamic stability dynamic instability and control concepts. 7. To know the loads taken by aircraft and type of construction and also construction materials in them.

Course Contents

Unit I	**Introduction to mobile robots**	**(04 Hrs.)**
Introduction to Mobile robots, Locomotion, Classification -Legged, hopping, Wheeled, Aerial, Key issues in locomotion , Degree of mobility and steerability, robot maneuverability, kinematic modelling of Mobile robot, Wheel kinematic constraints Motion control, Kinematic models of simple car and legged robots.		
Unit II	**Control of Mobile Robots**	**(04 Hrs.)**
Control theory, Control design basics, Cruise-Controllers, Performance Objectives, State space modelling of mobile robots, Linearization, LTI system , Stability, PID control, basic control algorithms, Low-level, control. State space control, backstepping control.		
Unit III	**Perception and Actuation**	**(04 Hrs.)**
Sensors for mobile robots, Classification, performance, uncertainty in sensors , Wheel sensor, Heading sensor, Accelerometer, Inertial measurement, Motion sensor, range sensors, Global positioning system (GPS), Doppler effect-based sensors, Vision sensor , Basics of computer vision, Image processing techniques, Feature extraction – image, Range data location recognition, Actuator systems: Types of motors, DC, AC servo systems, Linear actuation systems.		

Unit IV	Introduction and Design of UAV Drone Systems	(04 Hrs.)
Introduction to Unmanned Aircraft Systems, History of UAV drones, classification of drones, System Composition, Applications. Introduction to Design and Selection of the System, Aerodynamics and Airframe Configurations, Characteristics of Aircraft Types, Design Standards and Regulatory Aspects-India Specific, Design for Stealth.		
Unit V	**Avionics Hardware of Drones**	**(04 Hrs.)**
Autopilot, AGL-pressure sensors-servos-accelerometer - gyros-actuators - power supply-processor, integration, installation, configuration.		
Unit VI	**Payloads, Controls, Navigation and Testing**	**(04 Hrs.)**
Payloads, Telemetry, Tracking, controls-PID feedback, radio control frequency range, modems, memory system, simulation, ground test-analysis-trouble shooting. Waypoints navigation, ground control software, System Ground Testing, System In-flight Testing, Future Prospects and Challenges.		

Term Work

1. Calculation of steerability, mobility and maneuverability of various mobile robot wheel configurations
2. Designing of kinematic models of wheels.
3. Interfacing and speed control of Robot wheel using PWM signal
4. Tuning PID controller using ZN method and estimation of speed
5. Backstepping control of linear path.
6. Interfacing a GPS module to a mobile robot.
7. Range data detection using a LIDAR module and ultrasonic module.
8. To demonstrate speed control of BLDC Motor using PWM technique.
9. To measure the frequency and level of RF signals using of spectrum analyzer.
10. To configure, test and perform communication of FCB with motor, GPS, ESC and sensors.
11. To write technical specification sheet for different types of the drone and for it's application.
12. To identify different features of controls of HD and thermal image of camera used in drone.
13. To identify of different types of SMD IC packages.
14. To identify different types of ports and connectors.
15. To study and sketch various frame structure viz. quadcopter frame (plus shape, cross shape and H-shape), hexacopter frame (hexa+ and hexa S).
16. Practices on various drone assembly materials.

Textbooks

1. Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics.
2. Siegwart, Nourbakhsh, "Introduction to Autonomous Mobile Robots", MIT Press, 2011.
3. Thrun, Burgard, Fox, "Probabilistic Robotics", MIT Press, 2005.
4. S. M. LaValle, "Planning Algorithms", Cambridge University Press, 2006.
5. Howie M. Choset, Kevin M. Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, Sebastian Thrun, Ronald C Arkin · 2005 "Principles of Robot Motion: Theory, Algorithm & Implementations", MIT Press, 2005.
6. Roland Siegwant & Illah R. Nourbakhsh, Introduction to Autonomous Mobile Robots, MIT Press, 2004.
7. ASA Test Prep. Remote Pilot Test Prep — UAS: Study & Prepare. Wellfleet Press, 2016. 978-1577151326
8. Austin, Unmanned Aircraft Systems: UAVS Design, Development and Deployment. Wiley, 2010. 978-0-470-05819-0
9. Baichtal, Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs. Que Publishing, 2016. 978-0789755988
10. Beard & McLain, Small Unmanned Aircraft: Theory and Practice. Princeton University Press,

2012. 978-0691149219
11. Cares & Dickmann, Operations Research for Unmanned Systems. Wiley, 2016. 978-1-118-91894-4.

Reference Books

1. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.
2. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.
3. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007
4. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998.

Unit Tests

Unit Test-I	Unit- I,II, III
Unit Test-II	Unit- IV, V, VI

DESIGN OF INTEGRATED ROBOTIC CELLS

(Course No. 413)

Designation of Course	**Design of Integrated Robotic Cells**		
Teaching Scheme:	**Examination Scheme**		**Credits Allotted**
Theory: --- Hours/Week	End Semester Examination		
Practical: 04 Hours/Week	Internal Assessment		
	Term Work	25 Marks	02
	Oral/Practical	25 Mark	
	Total	**50 Marks**	**02**

Course Prerequisites: -	1. Drafting Software like Auto-CAD, CATIA 2. Robotic Simulation Software 3. Engineering Mathematics
Course Objectives: -	To provide knowledge about 1. Robot Cell Design 2. Robotic Design optimization techniques 3. Robotic Cell design in Manufacturing
Course Outcomes: -	The students should be able to 1. To Understand Robot cell design 2. To Understand robot control system design 3. To Design robot drive system 4. To Estimate robotic design optimization technique 5. To Design robot in Manufacturing 6. To Design mobile Robot

Course Contents

Unit-I	**Introduction to Robotic Cell Design Concept**	**04 Hrs.**
Principle of Robotic Cell Design, Robot Cell design outlet, Robotic cell design concept and process, objective tree in design, Function analysis, grant chart, Purpose of Experiment and test in design, design consideration for ocean robot.		
Unit-II	**Robot Control system design**	**04 Hrs.**
Feedback control system design, types of control systems, open and closed loop control systems, and state-space models, MATLAB SISO design tool.		
Unit-III	**Robot Drive Train Design**	**04 Hrs.**
Characteristics of servomotors and gearboxes in industrial robots, Trajectory generator, Design method - Motor model and Gear box model.		
Unit-IV	**Design Optimization Technique**	**04 Hrs.**
Characteristics of objective functions for design optimization based on robot simulations, Optimization algorithms - Gradient based algorithms, Genetic algorithms, The Complex algorithm, The Complex-RF, Complex-RD – A modified version for discrete variables, Complex-RFD – An optimization algorithm for mixed variables, Adaptive Complex method.		

Unit-V	Robotic Cell design and Manufacturing	04 Hrs.
Introduction, Application of Robotics cell in manufacturing, Inline Mechanical Assembly cell, Electronic Sensor assembly cell.		
Unit-VI	**Design of Mobile Robot**	**04 Hrs.**
The design criteria of mobile robot structure, movement type and wheel selection, material selection, Design calculation, Structural simulation by any analysis software.		

Term Work:

Term work shall consist record of minimum 8 experiments from the following.

1. Case Study of Robotic Cell Design Concept
2. Case Study of Robot Control system design
3. Case Study of Robot Drive Train Design
4. Case Study of Robotic cell Design Optimization Technique
5. Case Study of Robotic Cell design and Manufacturing
6. Case Study of Design of Mobile Robot
7. Case Study of Design of Agricultural application robot
8. Case Study of Design of Field and service robot
9. Case Study of Design of Bomb diffusing robot

Text Books:

1. M.P. Groover, "Automation, Production Systems & Computer Integrated Manufacturing", PHI, 3rd Edition, 2012.
2. M.P. Groover, M.Naegel, "Industrial Robotics, Technology, Programming & Applications", TMH, 2nd Edition, 2012.
3. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill Book co, 1987.

References Books:

1. J.G. Keramas, "Robotics Technology Fundamentals", Thompson Learning, 2nd Edition, 2002.
2. J.J. Craig "Introduction to Robotics Mechanics & Control", Pearson Education, 3rd Edition, 2004.
3. S.R. Deb, "Robotics Technology and Flexible Automation", TMH, 2nd Edition, 2010.
4. Mike Wilson, "Implementation of Robotic Systems"

PROJECT STAGE -II

(Course No. 414)

Designation of Course	**Project Stage -II**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - -- Hours/ Week	End Semester Examination	-- Marks	--
Tutorial: - --Hours/ Week	Internal Assessment	-- Marks	
Practical: - 04 Hours/ Week	Term Work	100 Marks	06
	Oral/Practical	100 Marks	
	Total	**200 Marks**	**06**

Course Prerequisites: -	The students should have knowledge of 1. Knowledge of basic concepts in Robot Programing. 2. Basic information of fundamentals of robotics. 3. Basic knowledge of Data Structures and Algorithm. 4. Knowledge of basic concepts in Robotics & Automation Engineering 5. Basic knowledge of robot design
Course Objectives: -	1. To fabricate the designed equipment 2. To conduct laboratory and field testing of the new equipment 3. To analyze performance of the equipment with different performance parameters 4. To make changes in design if necessary, based on the performance analysis 5. To prepare project report and deliver presentation. 6. To work sincerely as a member of team
Course Outcomes: -	The students should be able to– 1. Understand the latest changes in technological world and apply fundamental principles of science and engineering. 2. Create ability to identify, formulate and model problems 3. Understand importance of sustainability and cost-effectiveness in design and development of engineering solution. 4. Create ability to be multi skilled engineer with a good technical knowledge, management, leadership, entrepreneurship skills. 5. Create awareness of social, 6. Create ability to communicate efficiently.

Course Contents

Details of Project Stage -II

1. The project taken in the First semester will be continued as far as possible. In case after the training, the students wish to change their project, the same may be allowed after discussion with the faculty. The new project should be based on the training taken and should utilize the training experience.

   In Semester II concentration will be on

   - Experimentation work
   - Testing of equipment's
   - Preparing a project report

2. The work will be evaluated through three presentations with aim of observing the progress and suggesting modifications for completing the project.