M.Tech: Industrial Automation & Robotics
(2020 - 2022)

Scheme of Teaching and Examination &Syllabus

Department of Mechanical Engineering
The National Institute of Engineering, Mysuru

PREFACE

Dear Students,

NIE is a premier technical institution of the country started nearly seventy years ago. Right from its inception focus at NIE is to deliver value based education with academically well qualified faculty and infrastructure. NIE now offers seven UG and twelve PG programmes. Research activities undertaken at the institute has brought laurels and given unique status to our UG and PG programmes. The alumni of NIE have achieved excellence in their chosen professions and their accomplishments are of immense value to the Institute. It is a matter of pride that NIE continues to be the preferred destination for students to pursue an engineering degree.

In the year 2007, NIE was granted academic autonomy by Visvevaraya Technological University (VTU), Belagavi. From then onwards our prime focus is on developing and delivering a curriculum which caters to the needs of various stakeholders. The curriculum has unique features enabling students to develop critical thinking, solve problems, analyse socially relevant issues, etc. The academic cycle designed on the basis of Outcome Based Education (OBE) strongly emphasises continuous improvement and this has made our curriculum responsive to current requirements. Four UG programmes and two PG programmes were recently accredited under Tier-1 of the National Board of Accreditation (NBA), New Delhi. Other programmes are under the process of accreditation. NIE‘s progress towards further academic excellence is visualized in the realms of continuous improvement with increase in physical and intellectual infrastructure.

The curriculum at NIE has been developed by experts from academia and industry and it has unique features to enhance problem solving skills apart from academic enrichment. The curriculum of UG programmes has been thoroughly revised as per AICTE guidelines and we have incorporated unique features such as competency training, industry driven elective, long internship. The curriculum is designed in such a way so as to impart engineering education in a holistic way.

I hope you will have a fruitful stay at NIE.

Dr.RohiniNagapadma
Principal November 2020

Dear Student

It gives me great pleasure to welcome you to the National Institute of Engineering (NIE) where academics and activities never cease as students are groomed in the fields of engineering and technology. Our dedicated teams of highly talented faculty members are always trying to strive for academic excellence and overall personality development. The major emphasis of imparting training at NIE is to encourage enquiry and innovation among our students and lay the strong foundation for a future where they are able to face global challenges in a rapidly-changing scenario. Efforts are being made to design the curriculum based on Bloom‘s Taxonomy framework, to meet the challenges of the current technical education.

NIE is making sincere efforts in meeting the global standards through new formats of National Board of Accreditation, New Delhi and timely World Bank-MHRD initiative TEQIP (Technical Education Quality Improvement Program). A new curriculum based on AICTE model curriculum and guidelines of VTU, have been incorporated from current academic year. Several new unique initiatives in curriculum have been incorporated to make you all to be industry ready for pursuing your career after graduation. The new curriculum also carves you to pursue your higher studies after graduation.

We will make a genuine attempt in assisting you during the times of your trials and tribulations. You are exposed to the world of Engineering through a unique three week Induction Programme. We have also set up a Student Mentoring Programme (SMP) from the academic year 2016, through the voluntary efforts of the 3rd year students of your branch and our faculty members. You can approach them at any time during your stay at the NIE campus to address any of your concerns regarding either academic matters or life in the campus. In case of special needs, you are also advised to seek the help of the Student Welfare Officer or me.

I sincerely hope that your academic pursuit in NIE will be fruitful and enjoyable in every aspect Wishing you the very best.

Dr. M.S. Ganeshprasad November 2020
Dean (Academic Affairs)

REGULATIONS

ACADEMIC REGULATIONS

1. TITLE AND COMMENCEMENT:

1.1. These Regulations shall be called "The National Institute of Engineering, Mysuru, (NIE) Regulations under Visvesvaraya Technological University, Belagavi, Autonomous College Statutes - 2006 for Academic Autonomy – 2016 for Post graduate programmes".

1.2. This set of Regulations, on approval by the Governing Body, shall supersede all the corresponding earlier sets of regulations of the post graduate Degree programmes of VTU along with all the amendments thereto, and shall be binding on all students undergoing the Post Graduate Degree Programme(s) (Credit System) at NIE, Mysuru. This set of Regulations, may evolve and get refined or updated or amended or modified through appropriate approvals from the Academic Council and/or Governing Body from time to time, and shall be binding on all parties concerned, including the Students, Faculty and the Staff of Departments. The decision of the Governing Body shall be final and binding.

1.3. The provisions contained in this set of Regulations govern the policies and procedures on the Registration of students, imparting instructions of course, conduct of the examination and evaluation and certification of students' performance and all amendments there to leading to the award of the said Degree(s).

1.4. The Regulations shall come into effect from the date of obtaining approval from the Governing Body of the College.

2.0 ABBREVIATIONS:

a) "Academic Autonomy" means freedom to the College in all aspects of conducting its academic programmes, granted by the University for promoting excellence.

b) "Autonomous College" means The National Institute of Engineering, Mysuru, designated as an autonomous college by the University, as per the VTU Autonomous College Statute - 2006.

c) "Commission" means University Grants Commission (UGC).

d) Council" means All India Council for Technical Education (AICTE).

e) "Statute" means VTU Autonomous College Statute - 2006.

f) "University" means Visvesvaraya Technological University (VTU), Belagavi.

g) "Institute" or "College" means The National Institute of Engineering, Mysuru (NIE).

3.0. ACADEMIC CALENDAR:

3.1. The total duration of an academic programme shall be the same as that followed by the University. i.e., two years for M.Tech and three years for M.C.A. The maximum period which a student can take to complete a full time academic programme shall also be similar to that prescribed by the University, viz., double the nominal duration prescribed for the programme, i.e., four years for M. Tech. and six years for M.C.A. For students being admitted to 3rd semester M.C.A degree under the lateral entry scheme, the maximum duration to complete the course shall be the same as stipulated by the University.

3.2. Each academic year is split into two semesters. The term of the semester for teaching M.C.A is 16 weeks and for M.Tech. it is 18 weeks. Generally, each semester is of 20 weeks' duration which will include the period for teaching, examination and announcement of results. Typically, odd semester is from August to December and even semester is from January to May. In case of requirement under special circumstances, a Makeup Term of required duration as approved by the Academic Council may be offered in between even and odd semesters. The summer term, whenever offered, may be limited only to teach value added/add-on courses and or courses as approved by the Principal.

3.3. In general, the academic schedule of a semester includes the following:

- Date of starting semester.
- Course registration period.
- Dates of events of Continuous Internal Evaluation (CIE).
- Date of beginning of Semester End Examination (SEE).
- Date of announcement of results.
- Inter semester vacation period, if provided.
- Last working day of the semester

This academic schedule, shall be prepared by the Dean (Academic Affairs) in consultation with the Principal, approved by the Academic Council (AC) and shall be announced at least one week before the beginning of the semester.

3.4. In case of an eventuality of losing a teaching day due tounavoidable reasons, such a loss shall be made up by having a teaching / laboratory / tutorial session on a suitable day by adhering to the time table of the day which was lost.

4.0. ELIGIBILITY FOR ADMISSION:

4.1. Postgraduate Programmes:

a) Master of Technology Programmes:

Admission to First semester Master of Technology (M.Tech.) post graduate degree programme shall be open to the candidates who have passed any of the prescribed qualifying examinations of the degree courses recognized by the University for the respective M.Tech. programmes.

In addition to the above, the programme shall be open for candidates who have passed the prescribed Qualifying Examinations as specified for the respective programmes of study with not less than 50% of the marks in aggregate of all the semesters or years of the degree examination (cumulative sum of secured marks of all the semesters or years divided by the sum of the maximum marks). However, in the case of candidates belonging to SC/ST and Category-1, marks shall not be less than 45%.

b) Master of Computer Application Programmes:

Admission to First Semester Master of Computer Applications (M.C.A.) is open to the candidates who have passed any of the prescribed degree courses recognized by the University.

In addition to the above, the programme shall be open for the candidates who have passed the Bachelor degree examinations with not less than 50% of the marks in aggregate of all the years of the degree examinations. However, in the case of candidates from Karnataka belonging to SC/ST and Category-1, the aggregate percentage of marks in the qualifying examinations shall not be less than 45%. Provided that the candidate shall have passed Bachelor degree with not less than 50% of marks with Mathematics/ Statistics/ Computer Science/ Computer Programming/ Computer Applications / Business Mathematics/ Business Statistics as one of the optional or electives at degree level. Provided further that in respect of candidate who has studied and passed one of the subjects specified in the first provision in the Pre-University Course with 50% of marks in that subject shall also be considered for admission. However, in the case of candidates belonging to SC/ ST and Category-1, 45% of marks in that subject shall be considered for admission.

4.2 Admission to, III semester MCA for Lateral Entry Candidates, is open to the candidates who have passed any of the prescribed degree programme recognized by the University.

4.3 Relevant Government/University orders issued from time to time in this regard shall prevail.

5. ADMISSION and FEES:

5.1. Admission shall be made in accordance with the policy guidelines issued from the Ministry of Higher Education, Council, Government of Karnataka and University from time to time. Seats are reserved for candidates belonging to Scheduled Castes and Scheduled Tribes, physically challenged candidates, children of defense personnel and other categories as per the orders issued by the Govt. of Karnataka.

5.2. Admission for all postgraduate programmes shall be made through PGCET cell of Govt. of Karnataka or by conducting Institution level test as per the applicable Government/University notifications issued from time to time.

5.3. A limited number of admissions are offered to candidates under Management quota, in accordance with the rules applicable for such admission, issued from time to time by Govt. of Karnataka/Council.

5.4. After admission of a candidate to a programme, if it is found that he/she had in fact not fulfilled all the requirements stipulated in the offer of admission, in any form whatsoever, including possible misinformation etc., the Principal is authorized to cancel the admission of the candidate.

5.5. The College reserves the right to cancel the admission of any student and ask him/her to discontinue the studies at any stage of their career on the grounds of unsatisfactory academic performance or indiscipline or any misconduct.

5.6. The decision of the Principal regarding the admissions is final and binding.

5.7. Candidates must fulfill the medical standards required for admission.

5.8. Every student of the College shall be associated with the Parent Department offering the degree programme that the student undergoes throughout his/her study period.

5.9. The fee structure as stipulated by Govt. of Karnataka from time to time shall be applicable for all the admitted students.

6.0. PROGRAMME STRUCTURE:

6.1. The overall programme structure for a MCA/M.Tech Degree programme typically consist of the following components:

a) Engineering Mathematics.
b) Programme Core Courses.
c) Programme Elective courses.

d) Elective courses:

An elective course can be departmental elective, open elective, MOOC elective, Industry driven elective

e) Industrial training, Internship, Seminars and Project

6.2. The Departmental Council (DC) shall discuss and recommend the exact credits offered for the programme for the above components 'a' to 'e', the semester wise distribution among them, as well as the syllabi of all postgraduate programmes offered by the department from time to time before sending the same to the Board of Studies (BOS). The BOS will consider the proposals from the department and make recommendations to the Academic Council (AC) for consideration and approval.

6.3. The minimum Credit Requirement for the M.Tech. is 88 and for M.C.A. is 132. For students admitted to M.C.A under lateral entry scheme, the minimum credit requirement is 90.

6.4. SEMINAR AND PROJECT:

a) Project work / Dissertation of M.Tech. Shall be carried out by the student individually.

b) Project work at 6th semester MCA shall be carried out by the student individually.

c) Project viva-voce examination shall be conducted individually.

d) Seminar topic shall be selected from the emerging technical areas only.

7.0. REGISTRATION:

Each student after consulting his/her faculty advisor shall pre- register for the courses in every semester on the days specified for registration.

7.1. Mandatory Pre-registration for higher semester: To ensure proper planning of the academic activity, it is mandatory for all the students to undertake a pre-registration process well in advance before actual start of the next academic session. Typically, this pre-registration has to be completed during the last two weeks of the current semester for the following academic session except for minor modification during the 1st week of the ensuing semester

7.2. A student has to register for a minimum of 20 credits in each semester. The maximum number of credits a student can take in a semester is 30. However, the minimum/ maximum credit limit can be relaxed by the Principal, on specific recommendations of Departmental Council only under exceptional circumstances.

7.3. For a student to register for some courses he/she may be required to have adequate knowledge about one or many courses which are declared as pre-requisite courses in the earlier semesters. The student is deemed to have satisfied this requirement by satisfying the Clause of minimum attendance (Clause.9.11) in the course(s) which is/are declared as pre-requisite(s). The detailsof the pre-requisites will be announced by the Departmental Council as a part of the programme curriculum.

7.4. Late registration up to a cutoff date mentioned in the academic calendar is allowed on payment of a penal fee.

7.5. A student will be allowed to register for the next semester only when he/she fulfills the following conditions:

a) Cleared the entire previous semester fees due, if any, to the institute, hostel and library and also has paid all advance deposits of the Institute and hostel for the semester for which he/she is registering.

b) Satisfies all academic requirements, namely the credits earned and minimum CGPA, to continue with the programme. (Clause 9.10)

c) Not restrained from registering due to any specific reason by the college.

7.6. REGISTRATION IN ABSENTIA will be allowed only in exceptional cases at the discretion of Principal after the recommendation of the Departmental Council through the authorized representative of the student.

7.7. DROP-option: A student has the option to DROP courses until one week after the second event of CIE in consultation with his/her faculty advisor. However, the number of credits after dropping one or more courses shall satisfy Clause 7.2.

8.0. WITHDRAWAL FROM THE PROGRAMME:

8.1. Temporary Withdrawal:

a) A student who has been admitted to a post graduate degree programme of the college may be permitted to withdraw temporarily, for a period which is an integral multiple of a semester on the grounds of prolonged illness or grave calamity in the family or employment etc., provided that:

(i) The student applies to the College within at least 6 weeks of the commencement of the semester or from the date
he/she last attended the classes, whichever is later, stating fully the reasons for such withdrawal together with supporting documents and endorsement of his/her parent/guardian.

(ii) The College is satisfied that, even after counting the expected period of

withdrawal, the student has the possibility to complete his/her requirements of the degree within the time limits specified by the University.

(iii) There are no outstanding dues or demands, with the Department/ College/ Hostel/Library, etc.,

(iv) The tuition fees for all the subsequent semesters may be collected in advance based upon the severity of the case, before giving approval for such Temporary Withdrawal, until such time his/her name appears in the student's roll list. However, the fees/charges once paid would not be refunded.

(v) Scholarship holders are bound by the appropriate rules applicable to them.

(vi) The decision of the Principal of the College regarding withdrawal of a student is final and binding.

b) Normally, a student would be permitted to avail of the temporary withdrawal facility as a special case only once during his/her tenure as a student and this withdrawal period shall also be counted for computing the duration of study as specified by the University.

c) If the student has withdrawn from a programme for reasons of employment, when he / she rejoin the programme, he/ she should obtain necessary permission from his/her employer for rejoining. This permission letter has to be submitted at the time of rejoining.

8.2. Permanent Withdrawal:

Any student who withdraws admission before the closing date of admission for the academic session is eligible for the refund of the deposits only. Fees once paid will not be refunded.

Once the admission for the year is closed, the following conditions govern withdrawal of admissions:

a) A student who wants to leave the College for good, will be permitted to do so (and take Transfer Certificate from the College, if needed), only after remitting the tuition fees as applicable for all the remaining semesters and clearing all other dues if any.

b) Those students who have received any scholarship, stipend or other forms of assistance from the College shall repay all such amounts.

c) The decision of the Principal of the College regarding withdrawal of a student

is final and binding.

9.0.EVALUATION SYSTEM:

9.1. Each course has its Lecture – Tutorial – Practical (L-T-P) schedule. The credit for each course is based on following:

Lecture: one hour/week is given one credit.

Tutorial/Practical/ Project work: Two hours/ week is given one credit.

9.2. The evaluation of academic performance of a student is done as per Letter grading system. A ten-point Letter grading system is adopted which denotes the level of academic performance. The grade awarded to a student in a theory course shall be based on his/her performance in tests, assignments, quizzes, tutorials etc. in addition to Semester End Examination. The weightage of these components shall be as follows:

Continuous Internal Evaluation (CIE)	Quizzes, Assignments, Tutorials, Tests, etc**.** (As per Clause 9.5)	50%
Semester End Examination (SEE)	Written or online or practical	50%

9.3. Grades and Grade Points:

Absolute grading system shall be adopted as follows:

Level	Outstanding	Excellent	Very Good	Good	Average	Fail
Grade	S	A	B	C	D	F
Grade Points	10	09	08	07	05	0
Score (%)	90 &above	75-89	60-74	50-59	45-49	< 45

a) A minimum of 50% of marks has to be secured in CIE for appearing for a theory examination.

b) A minimum of 40% of marks has to be scored in SEE for passing a theory course.

c) A minimum of 45% of marks shall be obtained in (CIE+SEE) for passing a

theory course.

d) In a practical course, the candidate should secure a minimum of 45% for passing.

e) A candidate who does not secure minimum marks in CIE shall be awarded 'W' grade. The candidate shall repeat those courses wherein he/she has secured 'W' grade when the course is offered again in any subsequent semester.

f) A student who obtains fail grade in a course should repeat that course when it is offered in any subsequent semester.

9.4. The letter grade awarded to a student in a practical course is based on a suitable continuous evaluation scheme which the course instructor should evolve with the approval of Departmental Council. The student's performance in every practical class shall be evaluated and this shall have a weightage of 50%. He/she shall be evaluated further by conducting periodical tests and/or Semester End Test (SET) which shall have another 50% weightage. The grades shall be awarded based on these two evaluation components. The minimum passing marks for Practical/Drawing course is 45%.

9.5. The course instructor shall make an announcement within one week of the beginning of the semester about blown up syllabus, details of the evaluation scheme which includes distribution amongst various components. This announcement shall be made in both theory and practical course classes. A copy of this announcement should reach the office of Controller of Examinations (CoE).

9.6. Description of Grades:

S grade: This grade stands for Superlative grade which indicates outstanding achievement by the student.

A grade: This grade stands for excellent performance.

B grade: This grade stands for Very Good performance.

C grade: This grade stands for Good performance.

D grade: This grade stands for Average performance and is the minimum passing grade.

F grade: This grade denotes failure and hence very poor performance. A student who obtains 'F' grade in a course shall repeat that course in a subsequent semester or makeup term exam when it is offered. However, if a student gets 'F' grade in an elective theory course, he/she can register for the same elective or an alternative elective, as recommended by the Faculty Advisor and approved by the

Departmental Council to satisfy the credit requirement in subsequent semesters.

X grade: This grade is a transitional grade which denotes incomplete grade. A student having satisfactory attendance and having high CIE rating (>=90%) in a course, but SEE performance is poor, which could result in an overall 'F' grade in the course, will be awarded this grade. The DC can consider the request of any such student for a make-up examination and depending on the merit of the case and in consultation with the course instructor permit him/her to appear for make-up examination. The 'X' grade would be converted into one or the other of the letter grades (S/A/B/C/D/F) after the student completes the course requirements.

W grade: This grade is awarded to a student having satisfactory attendance at classes, but withdrawing from a course before the prescribed date in a semester under the advice of the Faculty Advisor. Withdrawal from a course shall be allowed only under exceptional circumstances and has to be recommended by the DC. No withdrawal is permitted after the grades are announced. Further, a candidate having shortage of attendance and/or fail to achieve the minimum requirements in CIE shall also be awarded this grade.

Calculation of SGPA and CGPA:

$$\text{SGPA}=\frac{\sum[(\text{course credits})\,X\,(\text{Grade points})]\text{ for all courses with Letter grades, including F (in that semester)}}{\sum[(\text{course credits})]\text{ for all courses with letter grades, including F (until that semester)}}$$

$$\text{CGPA}=\frac{\sum[(\text{course credits})\,X\,(\text{Grade points})]\text{ for all courses with Letter grades, including F (in that semester)}}{\sum[(\text{course credits})]\text{ for all courses with letter grades, including F (until that semester)}}$$

9.7. Process of Evaluation, Announcement and Review of Grades:

a) The evaluation procedure to be adopted by a course instructor shall be announced at the beginning of the semester, so that this procedure will be made known to all the registered students. A copy of this procedure shall be submitted within two weeks of the commencement of the semester to the Chairman of the DC and up on subsequent approval by the DC, it should reach the office of Controller of Examinations (CoE).

b) After the Semester End Examination (SEE), the papers will be evaluated and provisional results are announced. Then, as per the announcement made by Controller of Examinations (CoE) process of "paper seeing" will be arranged. During paper seeing, those students who wish to see their evaluated papers can meet the concerned Course Instructor and get clarification from him/her about the marks. The results are finalized after the event of paper seeing.

c) In case, a student has a grievance even after obtaining clarification from the

course instructor, he / she can make a written appeal to the respective Chairman of the Departmental Council and request for a review of the grade. The DC shall look into the details and make a recommendation. The recommendation of the DC shall then to be sent to the office of CoE for further processing as per "Examination manual" of the college. The processing fee for such an appeal will be decided by the Academic Council. If the appeal of the student is upheld by the review committee, the fee shall be refunded.

d) **Evaluation of Dissertation Work (Project work)**

(i) The topic and title of the dissertation shall be chosen by the candidate in consultation with the guide and co-guide if any, during the last fortnight of 2nd Semester. The topic selected should be from the major field of the post graduate studies of the candidate. A brief outlay of the action plan to carry out the dissertation work should be submitted by the candidate during first month of the 3rd semester. This action plan shall be scrutinized by the Departmental Council and subsequently approved.

(ii) The dissertation work shall be carried out by the candidate independently during 3rd& 4th semester under the guidance of one of the faculty members of the department who is designated as internal guide. If the dissertation work has to be carried out in any industry / Organization outside the College, permission to the effect should be first sought by the candidate. Further, it is mandatory to have a co-guide at industry / organization where work will be carried out. The name of the co-guide has to be specified in the action plan as detailed above.

(iii) At the end of the 3rd Semester there shall be a mid-term review of the dissertation work. For this purpose, the candidate may be asked to present a seminar where in the action plan submitted earlier vis a vis actual work carried out shall be reviewed and action plan for the remaining part of dissertation work finalized.

(iv) At the end of the 4th semester, the candidate shall submit 3 copies of report of the dissertation work duly approved by the guide & co-guide. The guide in consultation with Head of the department / PG program coordinator shall prepare a list of three external examiners. This list after being duly approved by the DC shall be sent to CoE along with 3 copies of dissertation work.

(v) The CoE shall send one copy of the dissertation work to the guide and another copy to one of the external examiners for evaluation. These examiners shall

evaluate the dissertation work and send the marks list independently to CoE. The maximum marks for this evaluation is 125 marks. The minimum marks for passing is 60% i.e. 75 marks as evaluated by external examiner. The average of the marks awarded by the two examiners shall be final marks and a candidate shall obtain a minimum of 60% for passing. The minimum passing grade is 'B'.

(vi) The examiners shall be given not more than three weeks for evaluating the dissertation report. The dissertation work shall not be accepted if external examiner opines that the dissertation work and report are not up to the expected standard and minimum passing marks cannot be awarded. The external examiner can totally reject the report or seek resubmission after incorporating suggested modification. He/she shall specifically quote reasons for rejection. In case he/she recommends for resubmission after modification, he/she shall list out specific areas where modification needs to be done. The resubmitted report in such cases shall be sent to the same external examiner. If he/she does not approve it again, the dissertation work shall be treated as 'rejected'. After the rejection by the first external examiner, the report is sent to another external examiner for evaluation. If he/she also does not approve the work, the candidate shall redo the dissertation work again. In all such cases the candidates shall be free to choose another topic for dissertation under a new guide, after re-registration with prescribed fee.

(vii) If the dissertation work is approved, the viva-voce examination of the candidate shall be conducted by the external examiner and internal examiner. It is the responsibility of the internal examiner / HoD to contact the external examiner and also the candidate and arrive at a convenient date & time for viva- voce. A copy of these communications shall be sent to CoE.

(viii) The viva- voce examination shall be carried out for a maximum of 75 marks. The minimum passing marks for this examination is 60% i.e. 45 mark. In case, the external examiner pleads his/her inability to conduct the viva- voce examination, substitute appointment shall be made by CoE in consultation with the guide and HoD.

(ix) The viva- voce marks awarded jointly by the examiners shall be sent to CoE immediately after the conduct of Viva-voce.

9.8. Make-up Examination:

The make-up examination facility would be available to students who have

secured 'F' or 'X' grade in SEE of a semester, make up examination can be held after each SEE or after SEE even semester with the approval of Academic Council of college. The standard of make-up examination should be the same as the regular SEE.

9.9. Vertical Mobility Requirements

9.9.1.For MCA:

a) A student shall register for a minimum of 20 credits in each semester.

b) Earned credits mean those credits for which the student would have obtained S / A / B / C / D grade.

c) The regular semester load is declared by the Departments for each programme at the beginning of every semester. Hence the yearly academic load is the sum of the regular semester loads of odd and even semester. Then the shortfall of credits=Yearly academic load – Earned credits. The threshold details at the end of every year are as follows:

shortfall =0 (All credits Earned)	shortfall of < =16 credits	Shortfall of credits >16
Eligible to move to next year.	Should complete the shortfall in credits by repeating only those courses for which 'F' or 'W' grade is obtained and move to the next year.	Not eligible to move to next year. Should repeat only those courses wherein he/she has obtained 'F' or 'W' grade. Hence in this case he/she is permitted to register less than 20 credits in a semester overriding the provisions of 9.10.1 (a).

When a student has to move from 2nd year to 3rd year, he/she should have completed all the credits registered in 1st Year except as per the following in (d)

d) A candidate is allowed to move to 3rd year if he/she has a maximum of two 'W' or 'F' grades in 1st and 2nd year put together with not more than one 'W' or 'F' grade in a semester during these years.

e) The minimum and maximum duration of the programme is as specified in Clause 3.1. If a student cannot complete the Programme in corresponding maximum duration, he/she shall leave the college without a degree. If a student

is not able to pass a credit course even after 5 (five) consecutive attempts he/she shall also leave the college without a degree. For this purpose, an attempt is defined as registration in a regular semester.

9.9.2. For M. Tech:

a) A student shall register for a minimum of 20 credits in each semester except in 3rd semester M.Tech.

b) Earned credits mean those credits for which the student would have obtained S / A / B / C / D grade.

c) The regular semester load is declared by the Departments for each PG programme at the beginning of every semester. Hence the yearly academic load is the sum of the regular semester loads of odd and even semester. Then the shortfall of credits = Yearly academic load – Earned credits. The threshold details are as follows:

Shortfall =0 (All credits Earned)	shortfall of credits < =16	Shortfall of credits >16
Eligible to move to next year.	Should complete the shortfall in credits by registering those courses for which 'F' or 'W' grade is obtained and move to the next Year	Not eligible to move to next year, should register for only those courses wherein he / she has **W** or **F** grade. Hence, he / she is permitted (if required) to register for less than 20 credits in a semester overriding the provisions of 9.10.2(a)

d) The minimum and maximum duration of the programme is as specified in section 3.1. If a student cannot complete the Programme in corresponding maximum duration, he/she shall leave the college without a degree. If a student is not able to pass a credit course even after 5 (five) consecutive attempts he/she shall also leave the college without a degree. For this purpose, an attempt is defined as registration in a regular semester.

9.10Attendance requirements:

a) Each student must attend every theory class, tutorial and practical sessions for which he/she has registered.

b) To account for approved leave of absence, representing the college in Sports/ Extracurricular / Placement / NCC or NSS activities), the attendance

requirement shall be a minimum of 85% of the classes actually held. Further condo nation by the Principal for a maximum of 10% attendance will be allowed to account for any exigencies like illness / medical emergency / death of a relative, with a specific recommendation by the HoD.

c) If a student has less than 75% attendance in any course, he/she shall be awarded 'W' grade in that course irrespective of his/her academic performance.

d) In a practical course, if a student misses four consecutive weeks of classes without any prior permission, he/she shall be awarded "W" grade in that course irrespective of his/her academic performance.

10.0. TERMINATION FROM THE PROGRAMME:

10.1. A student who is not performing well in terms of obtaining requisite grades and/ or is abstaining from the classes regularly, shall be warned of the consequences and the same shall also be communicated to his/her parents.

10.2. A student may be required to withdraw from the programme and leave the College on any of the following grounds:

a) Obtaining F Grade and hence not passing a course, in spite of five successive attempts;

b) A student failing to secure CGPA >= 5.0 on three consecutive years;

c) Absence from classes of all the registered courses for more than six weeks at a time in a semester without leave of absence being granted by competent authorities;

d) Failure to meet the standards of discipline as prescribed by the College from time to time.

10.3. Conduct and Discipline:

Students shall conduct themselves within and outside the premises of the College, in a manner befitting the students of an Institution of National Importance. As per the order of Honorable Supreme Court of India, ragging in any form is considered as a criminal offence and is banned. Any form of ragging will be severely dealt with.

The following acts of omission and/or commission shall constitute gross Violation of the code of conduct and are liable to invoke disciplinary measures:

a) Ragging

b) Lack of courtesy and decorum; indecent behavior anywhere within or outside the campus.

c) Willful damage or stealthy removal of any property/belongings of the College/ Hostel or of fellow students/citizens.

d) Possession, consumption or distribution of alcoholic drinks or any kind of hallucinogenic drugs.

e) Mutilation or unauthorized possession of Library books.

f) Noisy and unseemly behavior, disturbing studies of fellow Students.

g) Hacking in computer systems (such as entering into other Person's area without prior permission, manipulation and/or damage of computer hardware and software or any other Cyber crime etc.).

h) Plagiarism of any nature.

Commensurate with the gravity of offense, the punishment may be: reprimand, expulsion from the hostel, debarment from an examination, disallowing the use of certain facilities of the College, rustication for a specified period or even outright expulsion from the College, or even handing over the case to appropriate law enforcement authorities or the judiciary, as required by the circumstances.

For an offence committed in (i) a hostel (ii) a department or in a class Room and (iii) elsewhere within the college campus, the Chief Warden, the Head of the Department and the Student Welfare Officer shall meet as a committee and recommend for reprimanding or imposition of fine. Such recommendations shall be reported to the principal for further action.

11.0. STUDENTS' FEEDBACK:

a) It is recommended by the university that Autonomous Colleges obtain feedback from students on their course work and various academic activities conducted under the credit system. For this purpose, suitable feedback forms shall be devised by the College and the feedback obtained from the students regularly in confidence, by administering the feedback form in print or on-line.

b) The feedback received from the students shall be discussed at various levels of decision making at the College and the suggested changes/ improvements, if any, could be given due consideration for being implemented at the College level.

12.0. ACADEMIC COMMITTEES:

12.1. Departmental Council (DC): Constitution:

There shall be one DC for every department that is involved in the teaching for

the all the programme. The constitution shall be:

The Chairman may co-opt and/or invite more members

Functions:

a) To monitor the conduct of all programmes of the department.
b) To ensure academic standard and excellence of the courses offered by the department.
c) To oversee the evaluation of the students in a class, for each of the courses.
d) To develop the curriculum for all the programmes offered by the department and recommend the same to the BOS.
e) Moderation (only if and when found necessary) in consultation with the course instructor and approval of the finalized grades, before submission of the same to the office of the Principal.
f) To consider any matter related to all the programmes of the Department.
g) In cases where a course is taught by more than one faculty member, or by different faculty members for different sections of students, DC shall coordinate (only in case of need) among all such faculty members regarding the teaching and evaluation of such courses.
h) To conduct at least two meetings each semester and send the resolutions of the meeting to Principal, and also to maintain a record of the same in the department.
i) To attend to the appeals as follows:
    i) To receive grievance/complaints in writing from the students regarding anomaly in award of grades.
    ii) To interact with the concerned course instructor and the student separately before taking the decision.
    iii) The recommendations of the DC shall be communicated to the Principal for further appropriate action as required.
    iv) To recommend for suitable action against the concerned course instructor.
j) Any appropriate responsibility or function assigned by the Academic Council or the Chairman of the Academic Council or the BOS or the Chairman of the BOS.

12.2. Examination Malpractice Enquiry Committee:

Constitution:

1. Dean (Academic Affairs) Chairman
2. Controller of Examinations Member
3. Head of the Concerned Dept. Member
4. Concerned DCI on that Session Member
5. Member Sec., Academic Council, Member Convener

Functions:

a) This committee shall meet and recommend penal action depending on the severity of the malpractice in examination related cases as per the provisions of "Examination Manual" of the college.

b) The Principal shall take immediate action as per the approved Rules and the same shall be reported to the Academic Council / Governing Body.

12.3Faculty Advisor:

The Faculty Advisor, appointed by the HOD, shall be assigned a specific number of students of the concerned department that is offering the Programme and such students shall continue to be attached to the same faculty throughout their duration of study.

Functions (Highlights):

a) To help the students in planning their courses and activities during study.

b) To guide, advice and counsel the students on academic programme.

12.3. Course Instructor:

Functions (Highlights):

a) He /She shall announce the blown up syllabus, Abridged Lesson plan and details of evaluation pattern which includes distribution amongst various components of CIE within one week of beginning of semester.

b) He/she shall follow all the Regulations related to teaching of a course and evaluation of students.

c) He/she shall be responsible for all the records (answer books, attendance etc.,) of the students registered for the course.

d) He/she shall conduct classes as prescribed in the Academic calendar and as per the teaching assignment time table issued by the HOD.

e) He/she will arrange to distribute a teaching plan and the evaluation plan together with the course objectives, to all the students within the first week of each semester.

f) He/she will prepare an evaluation plan showing details of evaluation of the

student's performance in the course.

g) He/she will properly document the students' performance and maintain a record.

13.0. GRADUATION CEREMONY:

13.1. Graduation Requirements:

a) A student shall be declared to be eligible for the award of the degree if he/she has
   i) Fulfilled degree requirements in terms of earned credits.
   ii) No dues to the college, department, hostel, library central computer centre and any other centre or section of the college.
   iii) No disciplinary action pending against him/her.

b) The award of the degree must be recommended by the Academic / Governing Council.

13.2. GRADUATION:

a) College may have its own annual Graduation Ceremony for the award of Provisional Degrees to students completing the prescribed requirements of Academic programmes in each case, in consultation with the University and by following the provisions in the Statute. For the award of Prizes and Medals, the conditions stipulated by the Donor may be considered as per the statutes framed by the College for such awards.

b) College may also institute Prizes and Awards to meritorious students, for being given away annually at the Graduation Ceremony. This would greatly encourage the students to strive for excellence in their academic work.

BLUEPRINT OF SYLLABUS STRUCTURE AND QUESTION PAPER PATTERN

Blue Print of Syllabus Structure

1. For 4 credit courses complete syllabus is prescribed in SIX Modules as Module 1, Module 2, etc.
2. For 3 credit courses complete syllabus is prescribed in FIVEModules as Module 1, Module 2, etc.
3. For 2 credit courses complete syllabus is prescribed in THREEModules as Module 1, Module 2 and Module3.
4. In each module, there is one topic under the heading **"Self Learning Exercises" (SLE)**. These are the topics to be learnt by the student on their own under the guidance of the course instructors. Course instructors will inform the students about the depth to which SLE components are to be studied. SLE will carry questions with a weightage of 10% in SEE only. No questions will be asked on SLE components in CIE.

Blue Print of Question Paper

1. For 4 Credit Courses

i. Maximum Marks in SEE is 100 and duration of examination is 3 hours
ii. Question paper will have **SIX**full questions. One full question each of 15 marks (Question No 1, 2, 3, 4, 5 and 6) will be set from each module of the syllabus. Out of these six questions, two questions will have internal choice from the same module. The module from which choices are to be given is left to the discretion of the course instructor.
iii. Question No 7 will be set for 10 marks only on those topics prescribed as **"Self Learning Exercises".**

2. For 3 Credit Courses

i. Maximum Marks in SEE is 100 and duration of examination is 3 hours
ii. Question paper will have **FIVE**full questions. One full question each of 18 marks (Question No 1, 2, 3, 4 and 5) will be set from each module of the syllabus. Out of these five questions, two questions will have internal choice from the same module. The module from which choices are to be given is left to the discretion of the course instructor.
iii. Question No 6 will be set for 10 marks only on those topics prescribed as **"Self Learning Exercises".**

3. For 2 Credit Courses

i. Maximum Marks in SEE is 50 and duration of examination is 2 hours
ii. Question paper will have **Three**full questions. One full question each of 15 marks (Question No 1, 2 and 3) will be set from each module of the syllabus. Out of these three questions, one question will have internal choice from the same module. The module from which choice is to be given is left to the discretion of the course instructor.
iii. Question No 4 will be set for 5 marks only on those topics prescribed as **"Self Learning Exercises".**

CURRICULUM

&

SYLLABUS

NATIONAL INSTITUTE OF ENGINEERING

VISION

NIE will be a globally acknowledged institution providing value-based technical and scientific education through best-in-class talent.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

Moulding students of Mechanical Engineering with clear concepts and practical knowledge by imparting value based education for overall development as competent engineers.

MISSION

The Mechanical Engineering Department is committed to:

- Provide a strong foundation in mechanical engineering to make our engineers globally competitive.
- Inculcate creativity and passion to develop innovative solutions to engineering problems.
- Creating centers of Excellence to provide faculty and students with opportunities to strengthen their training research and leadership skills.
- Build relationships with globally acknowledged academic institutions and Industries in India & abroad to enhance our teaching and research proficiency.

GRADUATE ATTRIBUTES

1. Engineering Knowledge
2. Problem Analysis
3. Design/Development of Solutions
4. Conduct Investigations of complex problems
5. Modern tools usage
6. Engineer and Society
7. Environment and Sustainability
8. Ethics
9. Individual & Team work
10. Communication
11. Project management & Finance
12. Lifelong learning

PROGRAMME EDUCATIONAL OBJECTIVES

1. Graduates will be successful as engineers in the industry and provide solutions to problems faced in the multi-disciplinary field of Automation & Robotics.
2. Graduates will have the ability to be an integral part of research programmes and involve in a process of lifelong learning.
3. Graduates will address problems in the society in a professional & ethical manner with due attention to environmental issues.

PROGRAMME OUTCOMES

At the completion of two year post-graduate program, the students of Industrial Automation & Robotics, NIE are expected to acquire the abilities to:

PO1. Independently carry out research/investigation and development work to solve practical problems in Industrial Automation & Robotics.

PO2. Write and present a substantial technical report/document.

PO3. Demonstrate a degree of mastery over Industrial Automation & Robotics.

PO4. Employ Artificial Intelligence and robotics tool to cater into industrial automation needs in both discrete and process plants.

PO5. Provide solutions to varied engineering problems through the interpretation of data using modern computational tools.

PROGRAM SPECIFIC OUTCOMES

PSO1: Post-Graduation in Industrial Automation & Robotics prepares the students by providing training in the key interdisciplinary areas such as Drives, Plc, Scada, Artificial intelligence, Big data analytics, Vision sensor system, Mechatronics, Modeling-simulation, Industrial Robotics and Mobile robotics with hands-on experience.

PSO 2: Interaction and collaborations with outside industries and institutes to achieve good academic track records to enhance research and entrepreneurship skills.

SCHEME OF TEACHING AND EXAMINATION
Course Structure: I Semester

Sl. No.	Subject Code	Subject	Dept/ Board	Contact Hrs. / Week			Credits
				L	T	P	
01	APM1C01	Applied Mathematics	Mathematics	4	0	0	4
02	IAR1C01	Robotics for Industrial Automation	Mechanical	4	2	0	5
03	IAR1C02	Industrial Automation	Mechanical	4	2	0	5
04	IAR1C03	Drives and Control Systems for Automation	Mechanical	3	2	0	4
05	IAR1E1XX	Elective–I	Mechanical	3	0	0	3
06	IAR1E2XX	Elective –II	Mechanical	3	0	0	3
07	IAR1CRM	Research Methodology	Mechanical	2	0	0	2
08	IAR1L01	Laboratory – 1 (Drives and Controls)	Mechanical	0	0	2	1
			Total	**31**			**27**

C - Core

E - Elective

L -Laboratory

Sl.No	Code	Elective – I	Sl.No	Elective – II	
1	IAR1E101	Modeling, Simulation and Analysis of Manufacturing Systems.	1	IAR1E201	Computer Aided Production and Operation Management
2	IAR1E102	Finite Element Analysis	2	IAR1E202	Entrepreneurship Development
3	IAR1E103	Automatic Control Systems	3	IAR1E203	Artificial Intelligence and Expert Systems in Automation

SCHEME OF TEACHING AND EXAMINATION

Course Structure: II Semester

Sl. No.	Subject Code	Subject	Dept/ Board	Contact Hrs. / Week			Credits
				L	T	P	
01	IAR2C03	Big Data Analytics for Automation	Computer Science	4	2	0	5
02	IAR2C04	Microprocessors and Micro- Controllers	Electronics & Communication	4	2	0	5
03	IAR2C01	Computer Aided Engineering	Mechanical	4	0	0	4
04	IAR2C02	Sensors Applications in Manufacturing	Mechanical	3	2	0	4
05	IAR2E3XX	Elective - III	Mechanical	3	0	0	3
06	IAR2E4XX	Elective - IV	Mechanical	3	0	0	3
07	IAR2IXX	Industry Driven Elective	Industry	2	0	0	2
08	IAR2L01	Laboratory – 2 (Automation Laboratory)	Mechanical	0	0	2	1
Total				**31**			**27**

C - Core

E - Elective

I- Industry Driven Elective

L -Laboratory

Sl.No	Code	Elective - III	Sl.No	Elective - IV	
1	IAR2E302	Computer Vision and Image Processing	1	IAR2E401	Automotive Electronics
2	IAR2E303	Product Design & Development	2	IAR2E402	Additive Manufacturing
3	IAR2E304	Industrial Internet of Things	3	IAR2E403	Mathematical Approach to Robotic Manipulators

Sl.No	Code	Industry Driven Elective
1	IAR2I01	Advanced Embedded Systems
2	IAR2I02	Application of Labview in Automation
3	IAR2I03	Python Programming for Automation

SCHEME OF TEACHING AND EXAMINATION

Course Structure: III Semester

Sl. No.	Subject Code	Subject	Dept./Board	L	T	P	Credits
01	IAR3 MOOC1	MOOC-Elective (Management Stream) 12 weeks course	SWAYAM	-	-	-	3
02	IAR3 MOOC2	Open-MOOC-Elective (Any stream) 8 weeks course	SWAYAM	-	-	-	2
03	IAR3C02	Seminar/Paper presentation	Mechanical	0	0	0	1
04	IAR3C03	Internship (Industrial training for 8 weeks duration, at the end of training , students are required to submit a report and present a seminar)	Mechanical	0	0	0	5
05	IAR3C04	Project Phase-I (Students have to initiate the project work and at the end of the semester should present a progress seminar)	Mechanical	0	0	0	8
					Total Credits		**19**

MOOC - MOOC Elective

C - Core

SCHEME OF TEACHING AND EXAMINATION

Course Structure: IV Semester

Sl. No.	Subject Code	Subject	L	T	P	Credits
01	IAR4C01	Project –Phase2 (Students have to submit the final project report at the end of the semester which will evaluated followed by a seminar presentation and Viva-voce Examination)	0	0	0	15
Total number of Credits						**15**

Credit Structure

Subject	Credits
Core Courses	36
Elective Courses	12
MOOC Elective	05
Industry Driven Elective	02
Research Methodology	02
Seminars , Internship & Preliminary Project (III Semester)	14
Lab Components(1&2)	02
Major Project work (IV Semester)	15
TOTAL NUMBER OF CREDITS	**88**

Legend:

1) **L – Lecturers Hrs/ Week**
2) **T – Tutorials Hrs/ Week**
3) **P – Practical Hrs/ Week**
4) **SLE – Self Learning Exercise**

I Semester M.Tech [4-0-0]

(Common to IAR,MNT, MD & PEST)

Applied Mathematics

Sub Code	: APM1C01		**CIE** : 50% Marks
Hrs/Week	: 04		**SEE** : 50% Marks
SEE Hrs	: 03	**Total:** 52hrs	**Max.** : 100 Marks

Course outcomes:

On successful completion of the course the students will be able to:

1. Apply matrix and iterative methods to solve a system of linear algebraic equations.
2. Compute numerically the Eigen values and the corresponding Eigen vectors using diagonalization methods. Also compute the smallest and the largest Eigen values.
3. Define vector space, linear transformation, inner product of a vector space and apply the necessary concepts to compute orthonormal bases.
4. Use statistical tools to draw inferences for the given data.
5. Solve problems associated with continuous joint probability distribution, Markov chain using transition probability matrix and explain the concept of queuing theory.
6. Use optimization techniques to solve linear and non-linear programming problems.

Module I

Linear Algebra - 1

Solution of system of linear algebraic equations, Triangularization method, Cholesky's method, Partition method, Gauss Seidel iterative method (SLE: Gauss elimination method). **- 9 hrs**

Module II

Linear Algebra - 2

Eigen values & Eigen vectors, Bounds on eigen values-Gerschgorin's circle theorem. Given's method, Jacobi's method for diagonalisation of symmetric matrices, Rutishauser method for arbitrary matrices, Power method, Inverse power method (SLE: Analytical method to obtain eigen values and eigen vectors). **-9hrs**

Module III

Linear Algebra - 3

Vectors & vector spaces, Linear Transformations - Kernel, Range.Matrix of linear transformation.Inverse linear transformation, Inner product, Length / Norm.Orthogonality, orthogonal projections.Orthonormal bases.Gram-Schmidt process. (SLE: Least square problems). **- 8 hrs**

Module IV

Sampling Theory

Random sampling, Sampling distributions, Parameter estimation, Testing of hypothesis, Analysis of variance, Significance tests (SLE: Correlation and Regression). **- 9 hrs**

Module V

Probability

Joint probability distribution (Continuous), Markov chains – probability vector, stochastic matrix, transition probability matrix.Concept of queuing – M/M/I and M/G/M queuing system. (SLE: Discrete joint probability distribution). **- 8 hrs**

Module VI

Optimization

Standard form of LPP, Simplex method, Duality, Non-Linear programming problems
(SLE: Degeneracy in simplex method) Big-M method **- 9hrs**

Books for Reference:

1. Linear Algebra – Larson &Falvo (Cengage learning)
2. Higher Engineering Mathematics – Dr. B.V. Ramana, 5th edition, Tata McGraw – Hill publications.
3. Higher Engineering Mathematics – Dr. B.S. Grewal, 42nd edition, Khanna publication.

Probability and Statistics – Schaum Series **(**All latest editions**)**

4. Probability, Statistics and Random Processes-3rd Edition,Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008 - T.Veerarajan

Assessment Methods:
Test 1, 2 and 3 are evaluated for 25 marks each, out of which sum of best two for 50 marks are taken.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	P01,PO2,PO3	PSO1
CO2	PO1,PO3,PO4	
CO3	PO1,PO2,PO3,PO4	PSO1
CO4	PO1,PO3,PO4	PSO1
CO5	PO1,PO2,PO3,PO4	PSO1
C06	PO1,PO3,PO5	

Robotics for Industrial Automation [4-2-0]5

Sub Code: IAR1C01 **CIE:** 50% Marks

Hrs/Week: 04 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**100

Total: 52hrs

Course Prerequisites: None

Course Outcome:

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

1. Explain 3D translation and orientation representation &Illustrate the robot arm kinematics and use of Robot Operating System usage.
2. Design / Simulate a robot which meets kinematic requirements.
3. Apply localization and mapping aspects of mobile robotics.
4. To understand ROS applications.
5. To understand robot programming

Course Content

Module I:

Introduction: Definitions, Types of Robots, Application of Robots, Representing Position and Orientation, Representing Pose in 2-Dimensions, Representing Pose in 3-Dimensions, Representing Orientation in 3-Dimensions, Combining Translation and Orientation.

SLE: Matlab program for translation and orientation **8 hrs**

Module II:

Time and Motion: Trajectories, Smooth One-Dimensional Trajectories, Multi-Dimensional Case, Multi-Segment Trajectories, Interpolation of Orientation in 3D, Cartesian Motion, Time Varying Coordinate Frames, Rotating Coordinate Frame, Incremental Motion, Inertial Navigation Systems. Mobile Robot Vehicles, Mobility, Car-like Mobile Robots, Moving to a Point, Following a Line, Following a Path, Moving to a Pose.

SLE: Flying Robots **8 hrs**

Module III:

Navigation: Reactive Navigation, Braitenberg Vehicles, Simple Automata, Map-Based Planning,

Distance Transform, D*, Voronoi Roadmap Method, Probabilistic Roadmap Method, Localization, Dead Reckoning, Modeling the Vehicle, Estimating Pose, Using a Map, Creating a Map, Localization and Mapping, Monte-Carlo Localization.

SLE: Matlab programming of localization **9hrs**

Module- IV:

Robot Arm Kinematics: Describing a Robot Arm, Forward Kinematics, A 2-Link Robot, A 6-Axis Robot, Inverse Kinematics, Closed-Form Solution, Numerical Solution, Under-Actuated Manipulator, Redundant Manipulator, Trajectories, Joint-Space Motion, Cartesian Motion, Motion through a Singularity.

SLE: Joint Angle Offsets, Determining Denavit-Hartenberg Parameter **9hrs**

Module V:

Getting Started with ROS: Installing ROS, Understanding the ROS Filesystem level, Packages, Stacks, Messages, Services, Understanding the ROS Computation Graph level, Nodes, Topics, Services, Messages, Bags, Master, Parameter Server, Creating workspace, Creating & Building an ROS package, Creating & Building the node, Visualization of images, Working with stereo vision, 3D visualization, Visualizing data on a 3D world using rviz.

SLE: Saving and playing back data in ROS. **9hrs**

Module VI:

Robot Programming : Using Sensors and Actuators with ROS**,** SCORBOT structure, joint movements, work envelop, motors, encoders, microswitch, transmission, gripper, SCORBOT programming, IS-14533 : 2005 Manipulating industrial robots - Performance criteria related test methods, Mobile Robot Programming, Industrial Robot Programming.

SLE: Goals of AI Research, AI Techniques **9 hrs**

Text Books:

1. Robotics, Vision and Control: Fundamental Algorithms in MATLAB® - Peter Corke, Springer Tracts in Advanced Robotics, Volume 73, 2011
2. Learning ROS for Robotics Programming - Aaron Martinez & Enrique Fernández, Packt Publishing, September 2013

References:

1. Robotics for Engineers -YoramKoren, McGraw Hill International, 1st edition, 1985.
2. Industrial Robotics-Groover, Weiss, Nagel, McGraw Hill International, 2nd edition, 2012.
3. Robotics, control vision and intelligence-Fu, Lee and Gonzalez. McGraw Hill International, 2nd edition, 2007.
4. Introduction to Robotics- John J. Craig, Addison Wesley Publishing, 3rd edition, 2010.

Assessment Methods:

Test 1, 2 and 3 are evaluated for 25 marks each, out of which sum of best two for 50 marks are taken.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO3	PSO1
CO2	PO1,PO2,PO5	PSO1
CO3	PO1,PO3,PO5	PSO1
CO4	PO1,PO4,PO5	PSO1
CO5	PO1,PO4,PO5	PSO2

Industrial Automation (4-2-0)

Sub Code: IAR1C02 **CIE:** 50% Marks

Hrs/Week: 04 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Total** = 52 hrs **Max.Marks**:100

Course Outcome:

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

1. Select & identify suitable automation hardware for the given application.
2. Describe & explain potential areas of automation, material handling, and Fluid power systems.
3. Analysis of Manufacturing systems & Mathematical models of production lines
4. To know Industrial Automated production lines and work part transfer mechanism and buffer storage analysis.
5. To understand Cellular Manufacturing, Flexible manufacturing Systems ,planning implementation issues and implementation quality programs in production systems.

Course Content

Module I:

Introduction: Introduction , Automation In Production System, Manual Labor in production systems ,Principles and Strategies of Automation, Basic Elements of An Automated System, Levels of Automation, production concepts and mathematical models.

Material Handling: Introduction to Material Handling, Material Handling Equipment's, Principles and Design Consideration in material handling, Material Transport Equipment, Automated Storage systems.

SLE: Lean Manufacturing **09Hrs**

Module II:

Fluid Power and Pneumatic Systems:

Introduction to Fluid power, Pascal's Law, Hydraulic Circuit Design and Analysis-Introduction, Control of A Single-Acting Hydraulic Cylinder Circuit, Control of a Double Acting Hydraulic Cylinder Circuit, Regenerative Cylinder Circuit.

Basic Pneumatic systems, Types of Cylinders-Single acting Cylinder- Double acting Cylinder, Direction Control Valves- Valve position, Shuttle Valve, Basic Pneumatic Circuits- Control of

Single acting Cylinder Circuit- Control of Double acting circuit, Impulse operation- Pilot operation of single acting and Double acting cylinder.

SLE: Solenoid Operated Valve **10hrs**

Module III:

Manufacturing Systems: Introduction to Manufacturing systems, Components of Manufacturing systems, Classification scheme for Manufacturing systems ,Simple problems using Mathematic models of production performance, single station manufacturing cells, fundamentals of manual assembly lines, automated production lines.

SLE: Alternative Assembly lines. **08Hrs**

Module IV:

Automated Production Lines and Assembly systems:

Fundamentals of Automated Production Lines, Applications Of Automated production lines, System configurations, Work Part Transfer Mechanisms, Storage Buffers, Power Transmission Systems- Gears, Power Screws(Linear Guideways), Other Transmissions Systems such as chains and ropes.

SLE: System Design Considerations. **09 Hrs**

Module V:

Cellular Manufacturing and Flexible Manufacturing Systems:

Introduction, Part Families, Manufacturing Cells, Cellular Manufacturing, Part classification and coding, Production Flow Analysis, Group Technology and its applications.

Introduction to FMS, FMS Industrial Applications and its benefits, FMS components.

SLE: Planning and implementation issues. **08 Hrs**

Module VI:

Inspection and Quality control:

Introduction, Inspection, Specifying limits of variability, dimensions and tolerances, selection of gauging equipments, gauge control, quality control and quality assurance, statistical quality control, total quality management, six sigma, quality standards, Simple numerical problems.

SLE: Coordinate Measuring Machines. **08 Hrs**

Text Book:

Automation, Production Systems and Computer Integrated Manufacturing- M. P. Groover, Pearson Education. Third edition/Fifth edition, 2009.

References:

1. Fluid Power with Applications-Anthony Esposito, Peason, Sixth Addition.
2. Pneumatic Systems, Principles and Maintenance- SR Majumdar, 2011 Edition.
3. Industrial Robotics, Technology, Programming, and applications- MikellP.Groover.
4. Computer Based Industrial Control- Krishna Kant, EEE-PHI,2nd edition,2010
5. An Introduction to Automated Process Planning Systems- Tiess Chiu Chang & Richard A. Wysk.
6. Engineering Metrology and Measurements – N.V. Raghavendra, L.Krishnamurthy, 2018 Edition.

Assessment Methods:

Written Tests (Test 1,2& 3) are Evaluated for 25 Marks each out of which sum of best two for 50 marks are taken.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	**Programme Outcomes that are satisfied by the CO's**	**Programme Specific Outcomes that are satisfied by the CO's**
CO1	PO1,PO3,PO5	PSO1
CO2	PO1,PO2,PO3, PO5	PSO1,PSO2
CO3	PO1,PO2,PO4,PO5	PSO1
CO4	PO1,PO2,PO4,PO5	PSO1
CO5	PO1,PO3,PO5	PSO1

Drives and Control Systems for Automation [3-2-0]4

Sub Code: IAR1C03 **CIE:** 50% Marks

Hrs/Week: 03 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**100

Total: 39hrs

Course Prerequisites: None

Course Outcome:

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

1. Describe and analyze working principles of various types of motors, differences, characteristics and selection criteria, control methods, SCADA.
2. Apply the knowledge in selection of motors, heating effects and braking concepts in various industrial applications
3. Construct a program using PLC to problems pertaining to automation industries.
4. To understand visualization systems and its integrations

Course Content

Module I:

Introduction: Working principle of synchronous, Asynchronous & stepper motors, Difference between Induction and servo motors, Torque v/s speed characteristics, Power v/s. Speed characteristics, Vector duty induction motors, Concepts of linear and frameless motors, Selection of feedback system, Duty cycle, , V/F control, Flux Vector control.

SLE: Current control (sensor less vector control) **07 hrs**

Module II:

Industrials Drives: DC and AC motors operation and selection, method of control and application of brushless DC motor, PMSM, stepper motor, A.C servomotor, selection criteria for servo motor and servo amplifier, universal motor, electric drive, types of industrial drives, the characteristics of drive, advantages of drives over other prime movers, motor rating, heating effects, electric braking, rheostatic and regenerative braking principles in power converters.

SLE: The Hydraulic Motor **07 hrs**

Module III:

Introduction to Programmable Logic Controllers: Definitions of PLC, basic structure of PLC, working principles, data storage methods, inputs / outputs flag processing's, types of variables, definition of firmware, software, programming software tool and interfacing with PC (RS232 & TCP-IP), methods of PLC programming (LD, ST, FBD & SFC), What is logic, Conventional Ladder v/s PLC ladder, series and parallel function of OR, AND, NOT logic function blocks logical / mathematical operators & data types, array & data structure, PID, types of tasks and configuration, difference between relay logic and PLC, selection of PLC controller (case study) Centralized concept.

SLE: types of field bus systems **09 hrs**

Module IV:

Application of PLC using Timers and Counters. Timer and Counter Instructions; on delay and Off delay and retentive timer instructions, retentive timers,, Programming examples, Counter-counter up and down instructions, combining counters and timers, Comparison and data handling instructions, Arithmetic functions, Sequencer instruction, PLC Safety, Commissioning, Testing.

Visualization Systems, Types of visualization system, HMIs, PC based Controller, HIM Types, Applications of HMI's, and Interfacing of HMI with controllers. Programming of HMI.

SLE: Fault finding & Simulation, Implementation of HMI 0**8hrs**

Module V

Supervisory control & data Acquisitions: Introduction to Supervisory control & data Acquisitions, distributed Control System (DCS): computer networks and communication in DCS. different BUS configurations used for industrial automation – GPIB, HART and OLE protocol, Industrial field bus – FIP (Factory Instrumentation Protocol), PROFIBUS (Process field bus), Bit bus. Interfacing of SCADA with controllers, Basic programming of SCADA, SCADA in PC based Controller / HMI,

SLE: Case study & implementation for different examples. **08hrs**

Text Books:

1.Process Control Instrumentation Technology, Johnson Curties, Prentice hall of India, 8th edition

2.Andrew Parr, Industrial drives, Butterworth – Heineamann

3.G.K.Dubey.Fundamentals of electrical drives

4.Programmable Logic Controllers by W.Bolton

References:

1. Introduction to Programmable Logic Controllers by Garry Dunning, 2nd edition, Thomson, ISBN:981-240-625-5
2. Instrumentation Engineers Hand Book - Process Control, Bela G Liptak, Chilton book company, Pennsylvania
3. A.E. Fitzerald ,C.Kingsley and S.D Umans, Electric Machinery - McGraw Hill Int. Student edition
4. S.K.Pillai. A First course on electric drives –Wiley Eastern 1990
5. Programmable Logic Controllers by Hugh Jack.

Assessment Methods:

Test 1, 2 and 3 are evaluated for 25 marks each, out of which sum of best two for 50 marks are taken

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO3,PO4	PSO1
CO2	PO1,PO3,PO5	PSO1
CO3	PO1,PO3,PO4,PO5	PSO1
CO4	PO1,PO2,PO3,PO5	PSO1,PSO2

Modeling, Simulation and Analysis of Manufacturing Systems
[3-0-0]3

Sub Code:IAR1E101 **CIE:** 50% Marks

Hrs/Week: 03 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**100

Total: 39hrs

Course Prerequisites: None

Course Outcome:

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

1. Describe and explain model and analyze typical queuing scenarios
2. Develop and apply appropriate random number, random variable generation techniques &appropriate simulation statistical output techniques
3. Analyze appropriate input distributions and to explain simulation time advance mechanisms. Use the Arena simulation language to model and analyze problems found in industrial engineering practice and to design and analyze a simulation experiment.
4. Comparisons of systems and optimization techniques.

Course Content

Module I:

Principles of Modeling & Simulation: Basic Simulation Modeling, When simulation is appropriate, When simulation is not appropriate, Advantages and disadvantages and pit falls of Simulation, Monte - Carlo Simulation, Areas of Applications, Discrete and Continuous Systems, Modeling of a system, Types of Models, Discrete event simulation.

SLE: Steps in simulation study **7hrs**

Module II:

Modeling Approaches: List processing in simulation, Simple simulation language, Single server queuing systems, Time shared computer model, Multiteller banking with jockeying, Job shop model.

SLE: Simulation Software **8 hrs**

Module III:

Random Number Generation : Basic Probability and Statistics-Random variables and their properties, Properties of random numbers, generation of Pseudo random numbers, techniques for

generating random numbers, Various tests for random numbers-frequency test, and test for Autocorrelation.

SLE: General procedure for hypothesis testing **8 hrs**

Module IV:

Random Variate Generation: Introduction, different techniques to generate random variate: Inverse transform technique,-exponential, Normal, uniform, acceptance rejection techniques-Poisson distribution.

Output Data Analysis for a single system: Types of simulation with respect to output analysis, transient and steady state behavior of a stochastic process.

SLE: statistical analysis for terminating simulation **8hrs**

Module V:

Statistical Techniques: Comparison of two system design, Comparison of several system design – Bonferroni approaches to multiple comparisons for selecting best fit, for screening, Variance reduction Techniques such as simple linear regression, multiple linear regression. **Simulation Studies:** Simulation of Inventory Problems, Discrete Event Simulation problems

SLE: Optimization via simulation **8hrs**

Text Books:

1. Simulation, Modeling and Analysis –Averill Law & David M.Kelton, TMH, 4th Edition, 2007.
2. Discrete event and Simulation Systems – Banks & Carson, Prentice Hall Inc, 4th edition, 2011.

Reference Books:

1. System Simulation- Gordon, PHI, 2nd edition, 2009
2. Probability and statistics for engineers – Richard A. Johnson, Prentice hall, 7th edition, 2006.

Assessment Method:

Written Tests (Test 1,2& 3) are Evaluated for 25 Marks each out of which sum of best two for 50 marks are taken.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO2,PO4	PS01
CO2	PO1,PO3,PO4,PO5	PS01
CO3	PO1,PO2,PO4,PO5	PS01,PSO2
CO4	PO1,PO2,PO5	PSO1,PS02

Finite Element Analysis [3-0-0]3

Sub Code:IAR1E102 **CIE:** 50% Marks

Hrs/Week: 03 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**100

Course Prerequisites: None

Total: 39hrs

Course Outcome:

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

1. Describe and explain the concepts of Finite element analysis, matrix algebra,
2. Apply variational methods and solve problems in one dimensional and two dimensional analyses and apply various analytical methods such as Rayleigh-Ritz method, Galerkin method for solving cantilever beam problem and other structural problems. Solve problems in structural elements such as Trusses and Beams.
3. Derive element stiffness matrix and apply the concept of numerical integration to solve different problems.
4. Create a mathematical model, analyze and address various issues pertaining to structures.

Course Content

Module I:

Calculus of Variation: Introduction to Calculus of Variations, Introduction to Equilibrium Equations in Elasticity, Euler's Langrange's Equations, Principal of Virtual Work, Virtual Displacements, Principles of Minimum Potential Energy, Boundary Value, Initial Value Problems, Flexibility Approach, Different Problems in Structural Analysis.

SLE: Displacement Approach **7 hrs**

Module II:

FEM Procedure: Derivation of FEM Equations by Variation Principle Polynomials, Concept of Shape Functions, and Derivation for Linear Simplex Element, Interpolation Polynomials in Global and Local Coordinates.

SLE: Need for Integral Forms 8**hrs**

Module III:

Weighted Residual Methods: Concept of Weighted Residual Method, Derivation of FEMEquations

by Galerkin's Method, Solving Cantilever Beam Problem by Galerkin's Approach, Derivation of Shape Functions for CST Triangular Elements, Shape Functions for Rectangular Elements, Shape Functions for Quadrilateral Elements.

Higher Order Elements: Concept of Iso-Parametric Elements, Concept of Sub- Parametric andSuper –Parametric Elements.

SLE: Concept of Jacobian Matrix **8hrs**

Module IV:

Numerical Integration: Numerical Integration, One Point Formula and Two Point Formula for2D,Different Problems of Numerical Integration Evaluation of Element Stiffness Matrix,

SLE: Automatic Mesh Generation Schemes **8 hrs**

ModuleV:

Pascal's Triangle Law For 2D Shape Functions Polynomial, Pascal's Triangle Law for 3DShape Function Polynomials, Shape Function for Beam Elements, Hermitian Shape Functions.

Convergence: Convergence Criteria, Compatibility Requirements, Geometric Isotropy Invariance, Shape Functions for Iso-Parametric Elements, , Direct Method for Deriving Shape Functions using Langrage's Formula, Plane Stress Problems.

SLE: Special Characteristics of Stiffness Matrix **8hrs**

Text Books:

1.Finite Element Procedure- Bathe, PHI (EEE), 1st edition, 2009.

2.Finite Elements in Engineering – Chandrupatla, and Belagundu, Prentice Hall of India Pvt. Ltd., New Delhi, 3rd edition, 2009.

References:

1. The Finite Element Method – O. C. Zienkiewicz, R. L. Taylor. , TMHl, New Delhi, 5th edition, 2009
2. Concepts and Applications of Finite Element Analysis:- Cook.D Robert, Malus.S.David, Plesha E. Michel , John Wilely& sons 3rdEdn., New York, 2000
3. Finite Element Analysis – C.S.Krishnamoorthy, TMH, New Delhi, 1995.

Assessment Methods:

Written Tests (Test 1,2& 3) are Evaluated for 25 Marks each out of which sum of best two for 50 marks are taken.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO2,PO5	PSO1
CO2	PO1,PO2,PO5	
CO3	PO1,PO2,PO5	PSO1
CO4	PO1,PO2,PO5	PSO1

Automatic Control Systems [3-0-0]3

Sub Code:IAR1E103 **CIE:** 50% Marks

Hrs/Week: 03 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**100

Total: 39hrs

Course Prerequisites: None

Course Outcome:

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

1. Describe the concept of state variables and need of control system and applications of control charts.
2. Apply knowledge of mathematics, science and engineering to analysis and design classical linear control system.
3. Use modern computer tools such as MatLab tools to solve control problems.
4. Analyze various control aspects for the automation application.

Course Content

Module I:

Motivation for control. Review of differential equations, impulse response and Laplace transformations, Introduction to state equations and transfer functions.

SLE: Linear systems, Definition of stability **7hrs**

ModuleII:

Interpretation of poles and zeros of transfer functions. Time domain response of second order system.Command tracking and system type.Rough/Hurwitz test.

SLE: Stability and performance specifications **8 hrs**

ModuleIII:

Frequency response and frequency domain methods.Nyquist stability test. Bode plots. Phase and gain margins. Bode phase formula.

SLE: Lead/lag compensation **8 hrs**

Module IV:

Robustness.Uncertainty and performance weights.Robust stability test.Robust performance test. Loop shaping necessary and sufficient conditions. Bode integral formula.

SLE: PID controllers **8hrs**

Module V:

Applications of Root locus, Sensitivity of roots of characteristics equation, Tool for design and analysis of control systems, Case studies using mat lab on Bode ,Nyquist and Root locus.

SLE: Applications of root locus **8hrs**

Text Books:

1. Feedback Control of Dynamical Systems, 5th Edition, Franklin, Powell, and Enami-Naeini, Addison-Wesley, 2006
2. Control Systems Engineering – I.J .Nagrath, M.Gopal, 5th Edition; New age International (P) Ltd, Publishers.

Assessment Method:

Written Tests (Test 1,2& 3) are Evaluated for 25 Marks each out of which sum of best two for 50 marks are taken.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO3,PO4	PS01
CO2	PO1,PO3,PO4	PSO1
CO3	PO1, PO2,PO4, PO5	PS01
CO4	PO2, PO3, PO4, PO5	PSO1,PSO2

Computer Aided Production and Operation Management [3-0-0]3

Sub Code:IAR1E201 **CIE:** 50% Marks

Hrs/Week: 03 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**100

Total: 39hrs

Course Prerequisites: None

Course Out comes:

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

1.Describe production systems and their management

2.Solve inventory related problems in a manufacturing set up and suggest on controlling costs.

3.Formulate a Master Production schedule using Computers.

4. To understand the concept of Just - in - time

Course Content

Module I:

Management of production systems: Production system and its management, Classical, Behavioural& quantitative management, Introduction to CAP-OM.

SLE: Tasks of a Production Manager 7**hrs**

Module II:

Linear & Dynamic programming: Introduction, Canonical form of LP problems, Standard form of LP problems, Basic feasible Solution, The Simplex method of solution, Tabular method, Dynamic optimization models and programming.

SLE: Transportation and Assignment models **7 hrs**

Module III:

Forecasting and Capacity planning: Forecasting and analysis, spreadsheet models, time series analysis, simple moving average, weighted moving average, simple exponential smoothing, exponential smoothing and correction, linear regression, regression analysis and Delphi method. Capacity analysis basics, introduction to capacity planning methods, linear programming for aggregate planning, basics of facility layout methods.Introduction to Line Balancing, precedence requirements of operations, methods of solution, real life problem.

SLE: accuracy of forecasting **8hrs**

Module IV:

Inventory systems: Basic inventory systems, parameters of an inventory policy, costs associated with inventory policy, deterministic inventory models, simple EOQ model.

SLE: model for finite production rate **8 hrs**

Module V:

MRP system: Master Production Schedule, Production scheduling and sequencing, MRP System, Computation in a MRP system, Information provided by the MRP system, ERP system.

Just in time manufacturing: Kanban system, Dual card Kanban, Number of Kanbans Implementation of a JIT system.

SLE: Purchasing under JIT Modules in an ERP **09 hrs**

Text Books:

1. Operations Management: A Quantitative Approach, P. B. Mahapatra, Published 2010 by PHI Learning
2. Production Planning and Inventory Control, Narasimhan, McLeavey and Billington, PHI, 2nd edition, 2009.

References:

1. Production/Operations Management- Elwood S Buffa, Wiley Eastern, 8th edition, 1987 publication.
2. Production and Operations Management- Concepts, Models and Behavior, Adam & Ebert, PHI, 5th edition, 2009.

Assessment Method:

Written Tests (Test 1,2& 3) are Evaluated for 25 Marks each out of which sum of best two for 50 marks are taken.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO3, PO5	PSO1
CO2	PO1,PO3,PO4	PS01
CO3	PO1,PO3,PO5	PSO1,PSO2
CO4	PO1,PO2,PO5	PSO2

Entrepreneurship Development [3-0-0]3

Sub Code:IAR1E202 **CIE:** 50% Marks

Hrs/Week: 03 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**100

Total: 39hrs

Course Prerequisites: None

Course Out comes:

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

1. Describe the entrepreneurship process, requirements for motivation, opportunity assessment, critical factors for venture development.
2. Estimate financial requirements using sample project.
3. Demonstrate the knowledge of process involved in establishing an SME.
4. To understand strategic planning in entrepreneurship

Course Content

Module I:

The Entrepreneurial revolution: Entrepreneurs- challenging the unknown, Entrepreneurs/small business owners: A Distinction Entrepreneurship: A mind set, our entrepreneurial economy- The environment for entrepreneurship, the age of the gazelles, Emerging trends: the internet and E-Commerce, Entrepreneurial opportunities.The Evolution of Entrepreneurship: The Evolution of Entrepreneurship, the Myths of entrepreneurship, Approaches to entrepreneurship Process approaches, entrepreneurship (Corporate entrepreneurship) Corporate entrepreneurship: The nature of corporate entrepreneurship, conceptualizing corporate entrepreneurship strategy.

SLE: Sustaining corporate entrepreneurship **8 hrs**

Module II:

The Entrepreneurial individual: The entrepreneurial mindset, the dark side of entrepreneurship, entrepreneurial motivation.. Developing individual innovation: Entrepreneurs: Imagination and creativity, the role of creativity, arenas in which people are creative, innovation and the entrepreneur, the innovation process. Ethics and Entrepreneurship: The ethical side of enterprise, defining ethics, ethics and laws, establishing a strategy for ethical responsibility, ethics and business decisions, the social responsibility challenge, ethical considerations in corporate entrepreneurship,.

SLE: Ethical leadership by entrepreneurs. **8hrs**

Module III:

Opportunity Assessment in Entrepreneurship: The Challenge of New-Venture Start-Ups, Pitfalls in Selecting New Ventures, Critical Factors for New-Venture Development, Why New Ventures Fail, the Evaluation Process.Environmental Assessment in Entrepreneurship: Sustainable Competitive Advantage, the environment for New Ventures, A Macro view: The economic and industry environments, A Micro view: The community perspective. Entrepreneurial Ventures and Marketing Research: Marketing Research, Inhibitors to marketing research, developing the marketing concept, marketing stages for growing ventures, marketing planning, telemarketing, internet marketing, pricing strategies. Entrepreneurial Ventures and Financial Analysis: The importance of Financial Information for entrepreneurs, understanding the key financial statements, preparing financial statements, Pro Forma statements, Capital budgeting, break-even analysis, ratio analysis.

SLE: Entrepreneurial Ventures and Business Plan. **8hrs**

Module IV:

The legal Forms of Entrepreneurial Organizations: Identifying legal structures, sole proprietorships, partnerships, corporations, specific forms of partnerships and corporations, franchising, final thoughts: The legal environment and Entrepreneurship: Patents, copyrights, trademarks, bankruptcy, keeping legal expenses down.

SLE: Entrepreneurial Ventures **7hrs**

Module V:

Strategic Planning and Entrepreneurship: The nature of planning in emerging firms, strategic planning, the lack of strategic planning, the value of strategic planning, implementing a strategic plan, the nature of operational planning, The Challenge of Entrepreneurial Growth: Venture development stages, the entrepreneurial company in the 21st Century, building the adaptive firm, the transition from an entrepreneurial style to a managerial approach, understanding the growth stage, the international environment: global opportunities, achieving entrepreneurial leadership in the new millennium.

SLE: Methods of going international **8hrs**

Text Books:

1. “Entrepreneurship in the New Millennium”, Kuratko, Hodgetts, CENGAGE Learning, India

Edition 2007.

2. "Entrepreneurship Development", S Anil Kumar, S C Poornima, New Age International Publisher 2008

References:

1. "Entrepreneurship" Hisrich, 6th Edition, Tata McGraw-Hill Education, 2011.

2."The New Business Road Test" John Mullins, Pearson Education Limited, Third Edition, 2010.

Assessment Method:

Written Tests (Test 1, 2& 3) are Evaluated for 25 Marks each out of which sum of best two for 50 marks are taken.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO2	PSO2
CO2	PO3,PO5	PS01
CO3	PO2,PO5	PSO2
CO4	PO5	PSO2

Artificial Intelligence and Expert Systems in Automation

[3-0-0]3

Sub Code:IAR1E203 **CIE:** 50% Marks

Hrs/Week: 03 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**100

Total: 39hrs

Course Prerequisites: None.

Course Outcome:

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

1. Describe and explain the applications of AI,
2. select search strategies based on application requirement.
3. Explain knowledge representation methods, discuss architecture of expert systems.
4. Application of on-line search agent for purchase application.

Course Content

Module I:

Artificial Intelligence: What is AI?, The Foundations of Artificial Intelligence, The History of Artificial Intelligence,

Intelligent Agents: Agents and Environments, the Concept of Rationality, the Nature of Environments, the Structure of Agents.

SLE: State of the Art of AI applications **7hrs**

Module II:

Problem-solving: Problem-Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Breadth-first search, Uniform-cost search, Depth-first search, Depth-limited search, Iterative deepening depth-first search, Bidirectional search. Informed (Heuristic) Search Strategies, Greedy best-first search, A* search, Heuristic Functions, The effect of heuristic accuracy on performance.

SLE: Comparing uninformed search strategies **7 hrs**

Module III:

Beyond Classical Search: : Local Search Algorithms and Optimization Problems, Hill-climbing search, Simulated annealing, Local beam search, Genetic algorithms, Local Search in Continuous

Spaces, Searching with Nondeterministic Actions, Searching with Partial Observations, Online Search Agents and Unknown Environments.

SLE: Simulated annealing **8 hrs**

Module IV:

Knowledge Representation: Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, Reasoning Systems for Categories, Semantic networks, Description logics, Reasoning with Default Information, Truth maintenance systems.

SLE: The Internet Shopping World **7 hrs**

Module V:

Uncertain knowledge and reasoning: Quantifying Uncertainty, Acting under Uncertainty, Basic Probability Notation, Inference Using Full Joint Distributions, Bayes' Rule and Its Use, Probabilistic Reasoning, Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Exact Inference in Bayesian Networks, Approximate Inference in Bayesian Networks, and Inference by Markov chain simulation.

Probabilistic Reasoning over Time: Time and Uncertainty, Inference in Temporal Models, Hidden Markov Models, Kalman Filters, Dynamic Bayesian Networks, Expert system architecture.

SLE: Other Approaches to Uncertain Reasoning **10hrs**

Text Books:

1. Artificial Intelligence: A Modern Approach by StuartRussell and Peter Nowig*, PEARSON* 3rd Ed.

2. A Guide to Expert Systems - Donald A Waterman, Addison Wesley,2nd edition,1986.

References:

1. Introduction to Artificial Intelligence and Expert Systems – DAN.W.Patterson, PHI, 2nd edition, 2009.

2. Artificial Intelligence- George.F.Luger, Pearson Education, Asia, 3rd Edition,2009.

3. Artificial Intelligence: An Engineering Approach- Robert J. Schalkeff, PHI, Second edition, 1990.

Assessment Methods:

Written Tests (Test 1,2& 3) are Evaluated for 25 Marks each out of which sum of best two for 50 marks are taken.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO4,PO5	PSO1
CO2	PO1,PO3,PO4	PSO1
CO3	PO1,PO4	PSO1
CO4	PO1,PO2,PO4	PSO2

Research Methodology

[2-0-0]2

Sub Code:IAR1CRM **CIE:** 50% Marks

Hrs/Week: 02 **SEE:** 50% Marks

SEE Hrs: 2Hrs **Max.Marks:**50

Total: 26Hrs

Course outcomes:

After successful completion of this course, students will be able to:

1. Plan experiments according to a proper and correct design plan.
2. Analyze and evaluate experimental results (statistically), according to chosen experimental design.
3. Control and properly use fundamentals such as hypothesis testing, degrees of freedom,

Course Contents

Module I

Basic Concept:

Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, data collection using questionnaire and interviewing.

Research Formulation:

Components, selection and formulation of a research problem,

SLE: Criteria of good research.

8hrs

Module II

Research Hypothesis:

Criterion for hypothesis construction, nature of hypothesis, need for having a working hypothesis, characteristics and types of hypothesis, procedure for hypothesis testing.

Sampling Methods:

Introduction to various sampling methods

SLE: Limitations for Hypothesis test **9hrs**

Module III

Data Analysis:

Sources of data, collection of data, measurement and scaling technique, and different techniques of data analysis.

Thesis Writing And Journal Publication:

Writing thesis, writing journal and conference papers, IEEE and Harvard styles of referencing. Effective presentation, copy rights

SLE: Precautions of writing research reports. **9hrs**

Text Books:

1. C R Kothari "Research **Methodology**" New Age International second revised edition, 2014
2. Deepak Chawla, NeenaSandhi "**Research Methodology Concepts & Cases**" Vikas Publications, 2nd edition, 2011.

Reference Books:

1. Garg BL, Karadia, R Agarwal and Agarwal, **"An Introduction to Research Methodology,** RBSA Publishers 2002
2. Levine S.P and Martin, **Protecting Personnel at Hazardous Wastesites**, Butterworth, 1985, Blake R.P., Industrial Safety, Prentice Hall, 1953.
3. Sinha S.C. and Dhiman AK, **"Research Methodology",**Ess, Ess Publications, 2002
4. Fink A, "**Conducting Research Literature Reviews: From the internet to paper,** Sage Publications, 2009

Assessment Method:

Written Tests (Test 1 & 2) are evaluated for 25 Marks each out of which of best one for 25 marks is taken.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1	PSO1
CO2	PO1	PSO1
CO3	PO1,PO3	PSO1

Laboratory-1 [0-0-2]1
Drives Controls and Robotics Laboratory

Sub Code:IAR1L01 **CIE:** 50% Marks

Hrs/Week: 02 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**50

Course Outcomes:

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

1. Understand the working of PLC, SCADAand their application in industries.
2. Control drives with parameterization programming and soft PLC programming
3. Control robot through teach pendent

Course Contents

I.List of Experiments on PLC

1. Programs on logic based on solutions of AND, OR, NOT.
2. Latching concepts in PLC
3. Timer counter/ Mathematical operations

II.List of Experiments on Drives

1. Position control through command program
2. Velocity control through soft PLC
3. VFD speed control using commands

III.List of Experiments on SCADA:

1. Integration of PLC with SCADA and HMI
2. Creating tables in database and integration with SCADA
3. Screen development in SCADA and HMI in any three applications

IV.List of Experiments on KUKA Robotics:

1. Familiarization of Configuration
2. Movements of different robot axes
3. Point to Point, LIN, CIRC Operations
4. Sequencing and looping operations

Assessment Methods:

CIE	SEE
25	25

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO3,PO4,PO5	PSO1
CO2	PO1,PO3,PO4	PSO1
CO3	PO1,PO3,PO4,PO5	PSO1

Big Data Analytics for Automation [4-2-0]5

Sub code	**: IAR2C03**	**CIE**	**: 50%Marks**
Hrs / week	**: 04**	**SEE**	**:50% Marks**
SEE Hrs	**: 3 Hours**	**Max. Marks: 100 Marks**	

Total Hrs:52

Course Outcome

On successful completion of the course the students will be able to

1. Overview of Big Data and Related Technologies
2. Analyze Technologies for Handling Big Data and Hadoop Ecosystem
3. Acquire clear understanding of MapReduce Fundamentals and HBase
4. Acquire clear understanding of Virtualizing and Processing Data using MapReduce
5. Acquire a clear understanding of YARN and Mahout
6. Acquire a clear understanding of Hive

Course Contents

Module I

Getting an Overview of Big Data

What is Big Data? , History of Data Management – Evolution of Big Data, Structuring Big Data, Types of Data, Elements of Big Data, Volume, Velocity, Variety ,Veracity ,Big Data Analytics ,Advantages of Big Data Analytics, Use of Big Data in Social Networking, Use of Big Data in Preventing Fraudulent Activities, Use of Big Data in Retail Industry.

SLE: Future of Big Data in Automation Industry **9 hrs**

Module II

Introducing Technologies for Handling Big Data and Hadoop Ecosystem

Distributed and Parallel Computing for Big Data, Introducing Hadoop, How does Hadoop Function?, Cloud Computing and Big Data, Features of Cloud Computing, Cloud Deployment Models, Cloud Delivery Models, Cloud Services for Big Data, Cloud Providers in Big Data Market, In-Memory Computing Technology for Big Data, Hadoop Ecosystem, Hadoop Distributed File System, HDFS Architecture, Features of HDFS, MapReduce, Features of MapReduce, HadoopYARN,IntroducingHBase, Combining HBase and HDFS.

SLE:Sqoop, Flume **9hrs**

Module III

Understanding MapReduce Fundamentals and HBase

The MapReduce Framework, Exploring the Features of MapReduce, Working of MapReduce, Exploring Map and Reduce Functions, Techniques to Optimize MapReduce Jobs, Hardware/Network Topology,Synchronization, File System, Uses of MapReduce, Role of HBase in Big Data Processing, Characteristics of HBase

SLE : Installation of HBase **8 hrs**

Module IV

Understanding Big Data Technology Foundations and Processing your Data with MapReduce

Exploring the Big Data Stack,Virtualization and Big Data, Virtualization Approaches,Developing a Simple MapReduce Application, Points to Consider while designing MapReduce.

SLE: Managing Virtualization with Hypervisor **8 hrs**

ModuleV

Understanding Hadoop YARN Architecture and Mahout

Background of YARN, YARN Architecture, Working of YARN, YARN Schedulers, Backward Compatibility with YARN, YARN Configurations, YARN Commands,What is Mahout?, Machine Learning, Collaborative Filtering, Clustering, Classification, Mahout Algorithms, Environment for Mahout.

SLE: YARN Containers **8 hrs**

Module VI

Exploring Hive

Introducing Hive, Hive Services, Data Types in Hive, Built-In Functions in Hive, Hive DDL, Data Manipulation in Hive, Data Retrieval in Hive, Using Joins in Hive.

SLE: Getting Started with Hive Installation **10 hrs**

Textbook:

1. Big Data: Black Book, DT Editorial Services, Wiley India Pvt Ltd, 2015 Edition (Chapters 1,2,3,4,5,6,8,11,12,17)

Reference Books:

1. ArvindSathi, “Big Data Analytics: Disruptive Technologies for Changing the Game”, 1st Edition, IBM Corporation, 2012

2. Big Data Analytics with R and Hadoop, VigneshPrajapati, -Packt Publishing 2013

3. MichaelMinelli, Michehe Chambers, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business", 1st Edition, AmbigaDhiraj, Wiely CIO Series, 2013.

4. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", 1st Edition, Wiley and SAS Business Series, 2012.

5. Tom White, "Hadoop: The Definitive Guide", 3rd Edition, O'reilly, 2012.

6.Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data EMC Education Services, Wiley India Pvt Ltd.

Assessment Methods:

Test 1, 2 and 3 are evaluated for 20 marks each, out of which sum of best two for 40 marks are taken. Assignment is evaluated for 10marks. Total CIE marks is evaluated for 50marks.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO3,PO4	PSO1
CO2	PO2,PO3,PO4,PO5	PSO1
CO3	PO3,PO4,PO5	PSO1
CO4	PO2,PO3,PO4	PSO1
CO5	PO2,PO3,PO4,PO5	PSO1
CO6	PO2,PO3,PO4, PO5	PSO1

Microprocessors and Micro Controllers (4-2-0)

Sub Code:IAR2C03 **CIE:** 50%Marks

Hrs/Week:04 **SEE:** 50%Marks

SEEHrs:3Hrs **Max.Marks:**100

Course Prerequisites: None

Course Outcome:

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

1. Explain the internal organization of some popularmicroprocessors/microcontrollers.
2. Analyze the instruction set ofmicroprocessors/microcontrollers
3. Discuss IOT hardware and software interaction and integration.
4. Explain the design of AVR microcontrollers-based systems for mobile robotic applications.
5. Understanding of peripheral interfaces with sensors and motors.

Course Content

Module I:

Introduction to Microprocessors:

Introduction to Microprocessors, RISC and ARM design Philosophy, ARM Processor Fundamentals, registers, Current Program Status Register, Pipeline, Interrupts and Vector Table, Architecture Revisions, ARM Processor Families.

SLE: Core Extensions **8hrs**

ModuleII:

ARM Instruction Set

Data processing instruction, branch instructions, load store instructions, software interrupt instructions, program status register instructions, loading constants, conditional executions, efficient C programming for ARM processor.

SLE: Thumb instruction set **10hrs**

ModuleIII:

Introduction to Internet of Things:

IoT Definitions, IoT Frameworks, Internet of things application examples, Identification of IoT Objects and Services, Structural Aspects of the IoT Key, Iot Technologies.

IoT Protocols:

Application protocols- MQTT, LORA, CoAP, Infrastructure Protocols- WiFi, Bluetooth, Zigbee, RFIP, Wireless sensor networks.

SLE: BLE, Z-wave **10Hrs**

ModuleIV:

AVR Microcontroller:

Overview of AVR family, AVR Microcontroller architecture, Register, AVR status register, ROM space and other hardware modules. ATmega8 pin configuration and pin functions **8Hrs**

SLE: ATmega32 pin configuration and pin functions

ModuleV:

AVR Assembly Language Programming:

Addressing modes of AVR, Data transfer, Arithmetic, Logic and Compare, Rotate and Shift, Branch and Call instructions. AVR data types and assembler directives, AVR assembly language programs and I/O port programming **8 hrs**

SLE: AVR programming in C

Module VI:

Peripheral Interfacing:

LED and Keyboard Interfacing, ADC, DAC and IR sensor interfacing, Stepper Motor Interfacing, DC motor control. **8 Hrs**

SLE: SPI and I2C interfacing

Text Books:

1. ***"Advanced Microprocessors and IBM PC Assembly Language Programming"-*** K. UdayaKumar & B.S. Umashankar , TMH, 1st edition, 1996.

2. ***"The AVR Microcontroller and Embedded Systems Using Assembly and C"*****,** By Muhammad Ali Mazidi, SarmadNaimi and SepehrNaimi, Pearson Education.

3. ***"Programming and Customizing the AVR Microcontroller",*** By DhananjayGadre, McGraw Hill Education 3. AVR ATmega32 data sheet.

4. Vijay Madisetti, "***Internet of Things A Hands-On-Approach*****",** ArshdeepBahga, 2014.

5. Pethuru Raj and Anupama C. Raman, "***The Internet of Things: Enabling Technologies, Platforms, and Use Cases".***

6. ***ARM system developer's guide (Design and optimizing system software),*** Andrew N.Sloss, dominicsymes, chris wright, elsevier, New delhi 2011

Reference Books

1. The Intel Microprocessors-Barry .B.Brey, PHI, 8th Edition,2008.
2. Microprocessors and Interfacing- Douglas V.Hall, McGraw Hill, 3rd edition,2012.
3. Essentials of Assembly Language Programming -Rajaraman, Radhakrishna,

   PHI,1st edition, 2003.

Assessment Method:

Test 1, Test 2 and Test 3 will be conducted for 25 marks each, out of which the best of two is considered.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO3, PO2,PO5	PSO1
CO2	PO1,PO2,PO3, PO5	PSO1,PSO2
CO3	PO1,PO2,PO4,PO5	PSO1
CO4	PO1,PO2,PO4,PO5	PSO1
CO5	PO1,PO2, PO3,PO5	PSO1

Computer Aided Engineering [4-0-0]4

SubCode:IAR2C01 **CIE:** 50% Marks

Hrs/Week:03 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**100

Total:52hrs

Course Prerequisites: None

Course Outcomes:

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

1. Describe surface modeling and solid modeling, and use of Modeling and FEM in the design of mechanical system.
2. Design and perform manufacturing planning of mechanical system using state of the art CAD/ CAM and CAE tools. Create and manipulate 2D and 3D objects on graphic work station.
3. To understand FEM in order to apply for Industrial Automation. To understand heat transfer analysis with respect to one dimension.
4. To understand advances in CAD/CAM such as CIM,Rapidprototyping, concurrentEngg.

Course Content

Module I:

Computer Aided Design: Introduction, Conventional Approach to Design, Description of the Design Process, Parametric and Variation Designs, Engineering Analysis and CAD, Compute Aided Engineering, Integrated Database Management System in CAE, CAE product Development, CAE implementation.

SLE: Simulation Based Design. **8 hrs**

Module II:

Transformation and Manipulation of Objects: Introduction, Homogeneous Co-ordinate system, 2DTransformation-Translation, Scaling, Rotation, Mirroring, Reflection, Concatenation, and Manipulation of Simple Geometrical objects.

SLE: 3D Transformations **8 hrs**

Module III:

Curves and Surfaces: - Conic sections, Involutes, Cycloids, Spirals and other curves, Parametric equations- algorithms. Line Fitting, Non Linear Curve Fitting with a Power Function, Curve Fitting with a High Order Polynomial, Chebyshev Polynomial Fit. Cubic Splines, Bezier Curves, B-Spline Curve, Surface creation, Plane Surface, Ruled Surface, Rectangular Surface, Surface of Revolution,.

Solid Modeling: Introduction, Construction Techniques, Representation Schemes.

SLE: Application Software, Application of Solid Modeling. **10hrs**

Module IV:

Finite Element Modeling and Analysis: Introduction, Basic Concepts in FEM, Potential Energy Formulation and Closed form Solution, Galerkin Method, Bar element**:** Introduction, FE formulation, Proprieties of the Local Stiffness Matrix, Global Stiffness Matrix, Solution of the Truss Problem

10 Hrs

Module V

One Dimensional Heat Transfer: Introduction, Modes of Heat transfer, Governing equations, Finite element formulation, Conduction & Convection matrices & heat rate vectors. Heat transfer through Composite wall, Analysis of Fins.

SLE: Weighted Residual Method, Galerkin method **9hrs**

Module VI

Advances in CAD/CAM: CIM, Architecture, Objectives, CIM Implementation, Agile Manufacturing, Reverse Engineering, Concurrent Engineering, Rapid Prototyping, Virtual Manufacturing & Prototyping and Factory of the Future.

SLE: The Enterprise and Product Modeling **7 hrs**

Note: Demonstration classes of solid modeling are conducted for duration of 2 hours per week

Text Books:

1.Principles of Computer Aided Design and Manufacturing- Farid Amirouche,2nd Edition, Pearson Prentice Hall, 2003

2.CAD/CAM Theory and Practice- Ibrahim-Zeid, TATA McGraw Hill, 2nd edition, 2009.

3.Introduction to Finite elements in Engineering – ChandruPatla&Belagundu, 3rd edition, 2009.

References:

1. CAD/CAM/CIM – P. Radhakrishnan, New age international, 3rd edition, 2007.
2. Finite Element procedure- Bathe, Eastern Economy Edition. PHI, 2009

3. Interactive Computer Graphics- Principles & Practice- Foley &Vandam, 2nd Edition, 2006
4. CAD/CAM - P.N.Rao, 3rd edition, 2010.
5. Computer graphics- Hearn Donald & Beaker, M.Pauline, PHI, 3rd edition, 2009.

Assessment Methods:

Written Tests (Test 1,2& 3) are Evaluated for 25 Marks each out of which sum of best two for 50 marks are taken.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO2,PO5	PSO1
CO2	PO1,PO2,PO3,PO5	PSO1
CO3	PO3,PO5	PSO1
CO4	PO1,PO3,PO5	PSO1

Sensors Applications in Manufacturing [3-2-0]4

Sub Code:IAR2C02 **CIE:** 50% Marks

Hrs/Week: 03 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**100

Total: 39 hrs

Course Prerequisites: None

Course outcome:

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

1. Explain various signal condition devices used in electronic devises and use of appropriatemethod in signal conditions in various applications.
2. Describe impact of an RFID system onmanufacturing, defense, distribution, retail and health sectors &abstract ("filter") information in RFID.
3. Summaries the future advances to the quality and integrity of manufacturing and related sectors resulting from the use of RFID and other sensor technologies
4. Analyze and choose appropriate sensors in different industrial applications.

Course Content

Module I:

Fundamentals of Sensors and Transducers: Performance terminology, static and dynamic characteristics of transducers, classification of sensors and transducers, signal processing and signal conditioning. Operational amplifiers, filters, protection devices, analog to digital converter, digital to analog converter.

Sensors and their applications: 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, limit switches .

SLE: multiplexers and data acquisition systems **8 hrs**

Module II:

Advanced Sensor Technologies: Laser production, characteristics of lasers, types of laser sensors, bar code sensors, benefits of bar coding, transponder, RFID (Radio Frequency Identification), electro-magnetic identifier, optical encoders ,.color sensors, sensing principles, color theory, unit color measurement, colour comparator, color sensing algorithm, fuzzy logic color sensor, fuzzy logic for opt-electronic colour sensor in manufacturing.

SLE: Advantages and disadvantages of optical encoders **8hrs**

Module III:

Flexible Manufacturing Systems: Introduction of FMS, types , sensors used in FMS,integration sensors-Vision sensors(image capturing, image transformations and analysis), detecting partially visible objects, overlap and defects using vision sensors.

SLE: edge detection and extraction. **6hrs**

ModuleIV:

Sensors for Special Applications: 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(predictive monitoring serving the CIM strategy, optical sensor quantifying acidity of solution, reflective strip imaging camera sensor, ultrasonic stress sensor for measuring dynamic changes in materials, acousto optical synthetic aperture radar, sensors for vibration measurement of structures), collection and generation of process signals in decentralized manufacturing system.

SLE: Non-contact Sensors (pyrometers) multi sensor applications **9hrs**

ModuleV:

Networking: Networking of sensors, control of manufacturing process- tracking- the mean time between operations interventions, tracking the yield , mean process time, detection of machining faults, diagnostic systems, resonance vibration analyzer, sensing motor current for signature analysis, temperature sensing(RTD, thermocouple).

SLE: acoustic sensing**.** **8 hrs**

Text Books:

1. Sabnesoloman, sensors & control systems in manufacturing. Mc-Graw Hill book Company Network, 1994.
2. Mechatronics by W.Bolton,

References:

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

Assessment Methods:

Test 1, Test2 and Test 3will be conducted for 25 marks each, out of which best of two is considered

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO3,PO4	PSO1
CO2	PO1,PO2,PO4	PSO1
CO3	PO1,PO3,PO4	PSO2
CO4	PO1,PO3,PO4,PO5	PSO1

Computer Vision & Image Processing [3-0-0]3

Sub Code: IAR2E302 **CIE:** 50% Marks

Hrs/Week: 03 **SEE**: 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**100

Total: 39hrs

Course Prerequisites: None

Course Outcome:

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

1. Understand the applications of computer vision in automation
2. Describe image processing techniques, feature detection and matching techniques.
3. Describe image segmentation and stereo correspondence techniques.
4. Demonstrate the use of multi view stereo.

Course Content

Module I: Introduction: Computer Vision,Brief History, Image formation, Geometric primitives and transformations, Geometric primitives, 2D transformation, 3D transformation, 3D rotation, 3D to 2D projection, Lens distortion, Photometric image formation, Lighting, the digital camera, sampling and aliasing, color.

SLE: Image compression **8 hrs**

Module II: Image processing: Point operators, Pixel transforms, color transforms, compositing and matting, histogram equalization, Linear filtering, separable filtering, examples of linear filtering, band pass and steerable filter, More neighborhood operators , non -linear filtering, morphology, distance transform, Fourier transforms , Fourier transform pairs, two dimensional Fourier transforms, wiener filtering, Geometric transformations , parametric transformation, mesh based warping, Global optimization, regularization, Markov random fields.

SLE: Image restoration **10hrs**

Module III: Feature detection and matching : Points and patches , Feature detectors , Feature descriptors, Feature matching , Feature tracking , Edge detection , Edge linking , Lines, Successive approximation, Hough transforms, Vanishing points .

SLE: Rectangle detection. **7hrs**

Module IV: Segmentation: Active contours , snakes, dynamic snake and condensation, scissors, level sets, Split and merge , watershed, region splitting, region merging, graph based segmentation, probabilistic aggregation, Mean shift and mode finding , K-means and mixtures of Gaussians , mean shift, Normalized cuts , Graph cuts and energy-based methods .

SLE: Medical image segmentation **7hrs**

Module V: Stereo correspondence: Epipolar geometry, rectification , plane sweep, Sparse correspondence , 3D profiles and curves, Dense correspondence , similarity measures, Local methods , sub – pixel estimation and uncertainty, Global optimization, dynamic programming, segmentation based techniques, Multi-view stereo

SLE: Volumetric and 3D surface reconstruction **7hrs**

Text Books:

1. Computer Vision: Algorithms and Applications, Richard Szeliski , 2010 Springer.

Reference Books:

1. ComputerVision - A modern approach by D. Forsyth and J. Ponce, Prentice Hall

2. Robot Vision by B. K. P. Horn, McGraw-Hill.

Assessment Methods: Written Tests (Test 1,2& 3) are Evaluated for 25 Marks each out of which sum of best two for 50 marks are taken.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO3,PO4,PO5	PSO1
CO2	PO1,PO2,PO4,PO5	PSO1
CO3	PO2,PO3,PO4,PO5	PSO2
CO4	PO3,PO4,PO5	PSO1

Product Design and Development [3-0-0]3

Sub Code: IAR2E303 **CIE:** 50% Marks

Hrs/Week: 03 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**100

Total: 39Hrs

Course Prerequisites: None

Course Outcome:

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

1. Describe the design procedures involved in product development process,
2. Illustrate DFM and prototyping practices for new product development.
3. Develop concepts and select suitable concepts through application of Pugh selection.
4. Build product architecture and conceptualize industrial design for the product.

Course Content

Module I:

Introduction: Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development.

Development Processes and Organizations: A generic development process, concept development: the front-end process, adopting the generic product development process, product development organizations.

SLE: Product Development Practices followed by different companies. **7hrs**

Module II:

Product Planning: The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

Identifying Customer Needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.

SLE: Preparation of Questionnaire for concepts **7hrs**

Module III:

Concept Generation: The activities of concept generation clarify the problem, search externally, search internally, explore systematically, and reflect on the results and the process.

Concept Selection: Overview of methodology, concept screening, and concept scoring

SLE: Pugh Selection for one problem solution **8hrs**

Module IV:

Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.

Product Architecture: What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.

SLE: Hand sketching / CAD model creation of the concept. **7hrs**

Module V:

Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

Prototyping: Prototyping basics, principles of prototyping, technologies, planning for prototypes.

Industrial design: Importance of industrial design, industrial design process, assessing the quality of industrial design.

SLE: Advantages & Limitations of rapid prototyping **10hrs**

Text books:

Product Design and Development- Karl.T.Ulrich, Steven D Eppinger, Irwin McGrawHill, 5th edition, 2011.

References:

1. Product Design and Manufacturing- A C Chitale and R C Gupta, PHI 3rd Edition, 2003.
2. New Product Development- Timjones. Butterworth Heinmann, Oxford. UCI. 1997
3. Product Design for Manufacture and Assembly-GeofferyBoothroyd, Peter Dewhurst and Winston Knight, 3rd edition, 2010.

Assessment Method:

Written Tests (Test 1,2& 3) are Evaluated for 20 Marks each out of which sum of best two for 40 marks are taken. An assignment for 10 marks to be submitted by students.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO2,PO5	PSO1
CO2	PO1,PO2,PO3,PO5	PSO1
CO3	PO2,PO5	PSO1
CO4	PO1,PO2,PO4	PSO2

Industrial Internet of Things [3-0-0]3

Sub Code: IAR2E304 **CIE:** 50% Marks
Hrs/Week: 03 **SEE:** 50% Marks
SEE Hrs: 3Hrs **Max.Marks:**100

Total Hrs: 39

Course Prerequisites: Drives and control systems for automation.

Course Outcome:

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

CO 1. Use IoT Sensors for data logging and communicate the data to cloud
CO 2. Use IoT Sensors data in AI & ML
CO 3. Automate different process using sensors and control components
CO 4. Understand IOT alliances/hardware and standards

Course Content

Module I:

Introduction to Industrial IoT: IoT background, History and definition, IoT enabling factors, IoT use cases, IoT key technologies, I-IoT – Fourth industrial revolution, use cases of the I-IoT, Similarities and differences of IoT and I-IoT, IoT analytics and AI, Industry environment scenarios covered by I-IoT.

SLE: IoT application example 6hrs

Module II:

Understanding the Industrial process and devices: Industrial process, automation in the industrial process, control and measurement systems, types of industrial process, The CIM pyramid, CIM pyramid architecture – devices and networks, CIM network, The I-IoT data flow, The Industrial IoT data flow in a factory, The edge device, The Industrial IoT data flow in the cloud. Industrial data flow and devices, The I-IoT data flow in the factory, Measurement and the actuator chain.

SLE: IoT Frameworks 7hrs

Module III:

Understanding of NodeMCU, Open Source MicrocontrollerPlatform, Node GPIOPins, and Basics of Electronics. Introduction toEsp8266,Wifi Network, Web serve. CloudServers.

IoT Sensors- Temperature, HumiditySensor, Light ,Gyro, Inclination, Magneto, Pressure, Flow, Aqua, Position, vibration and acoustic sensors.

Protocol -MQTT Protocol, HTTP vs MQTT, Creating Adafruit account, Using Adafruit to read sensors value and send data to NodeMCU

SLE: ZigBEE IP technology 8 hrs

Module IV:

Implementing the I-IoT data flow: Discovering OPC, OPC classic, The data model and retrieving data in OPC classic, OPC UA, The OPC UA information model, OPC UA sessions, OPC UA security model, The OPC UA data exchange, OPC UA notifications, Understanding the I-IoT edge, Features of the edge – edge gateway, edge tools, edge computing, The I-IoT edge architecture, Edge implementations – Azure IoT edge, Green grass, Android IoT, Node red, Docker edge, Intel IoT gateway, Edge Internet protocols, I-IoT data

sources and data gathering, Edge deployment and data flow scenarios, Edge on field bus setup, Edge on OPC DCOM, Edge on OPC proxy, Edge on OPC UA, OPC UA on the controller.
SLE: IPv6 technologies for IoT 9hrs

Module V:
Understanding of I-IoT data loggers: Internal architecture of I-IoT data logger, communication protocols, I/O modules (Digital and Analog).
Configuring I-IoT data logger through a web based application, Establishing communication betweenPLC and I-IoT data logger. Interfacing of industrial sensor with I-IoT data logger.
Development of cloud based applications for the Mechatronics systems using the I-IoT data logger thorough web portal.
SLE: Integration of vision camera with IoT data logger 9hrs

Text Books:
1. Hands on Industrial Internet of Things by GiacomoVeneri and Antonio Capasso, Packt publisher. 2018 edition (e- book).

References:
1. Internet of Things (A Hands-on-Approach) 1st Edition by ArshdeepBahga and Vijay Madisetti, 2014, VPT publisher.
2. Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications by Daniel Minoli, Wiley; 1st edition (10 July 2013).

Assessment Methods:
Three tests will be conducted for 20 marks each. One assignment for 10 marks, where in the student needs to carry out an IoT project and submit a report for the same. CIE evaluation: Best of two tests marks will be taken along with 10 marks for assignment.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1, PO3, PO4, PO5	PSO1, PSO2
CO2	PO4, PO5	PSO1
CO3	PO1, PO3	PSO1, PSO2
CO4	PO1,PO3, PO5	PSO1

Automotive Electronics [3-0-0]3

Sub Code: IAR2E401 **CIE:** 50% Marks

Hrs/Week: 04 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**100

Total Hrs: 39

Course Prerequisites: None

Course outcome:

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

1. Describe and explain various sensors
2. Describe communications & Instrumentation used in automobile.
3. Summaries HVAC & Air/Fuel system of an automobile.
4. Analyze the importance of engine performance data for automobile.

Course Content

ModuleI:

Automotive Fundamentals Overview: Four Stroke Cycle, Engine Control, Ignition System, Spark plug, Spark pulse generation, Ignition Timing, Drive Train, Transmission, Brakes, Steering System, Battery.

SLE: Starting System. **06hrs**

Module II:

Sensors – Oxygen (O2/EGO) Sensors, Throttle Position Sensor (TPS), Engine Crankshaft Angular Position (CKP) Sensor, Magnetic Reluctance Position Sensor, Engine Speed Sensor, Ignition Timing Sensor, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Manifold Absolute Pressure (MAP) Sensor - Strain gauge and Capacitor capsule, Engine Coolant Temperature (ECT) Sensor, Intake Air Temperature (IAT) Sensor, Knock Sensor, Airflow rate sensor, Throttle angle sensor. Actuators – Fuel Metering Actuator.

SLE: Fuel Injector, and Ignition Actuator. **8hrs**

Module III:

Exhaust After-Treatment Systems – AIR, Catalytic Converter, Exhaust Gas Recirculation (EGR), Evaporative Emission Systems Electronic Engine Control – Engine parameters, variables, Engine Performance terms, Electronic Fuel Control System, Electronic Ignition control, Idle speed control.

SLE:EGR Control. **8 hrs**

Module IV:

Communication – Serial Data, Communication Systems, Protection, Body and Chassis Electrical Systems, Remote Keyless Entry, GPS Vehicle Motion Control – Cruise Control, Chassis, Power Brakes, Antilock Brake System (ABS), Electronic Steering Control, Power Steering, Traction Control.

SLE: Electronically controlled suspension. **8 hrs**

Module V:

Automotive Instrumentation – Sampling, Measurement & Signal Conversion of various parameters Integrated Body – Climate Control Systems, Electronic HVAC Systems, Safety Systems – SIR, Interior Safety, Lighting, Entertainment Systems Automotive Diagnostics – Timing Light, Engine Analyzer, On-board diagnostics, Off-board diagnostics, Expert Systems Future Automotive Electronic Systems – Alternative Fuel Engines, Collision Avoidance Radar warning Systems, Low tire pressure warning system, Radio navigation,

SLE: Advance Driver Information System. **9hrs**

Reference Books:

1. William B. Ribbens, "Understanding Automotive Electronics", 6th Edition, SAMS/Elsevier Publishing

2. Robert Bosch Gambh, Automotive Electrics Automotive Electronics Systems and Components, 5th edition, John Wiley& Sons Ltd., 2007.

Assessment Methods:

Written Tests (Test 1,2& 3) are Evaluated for 25 Marks each out of which sum of best two for 50 marks are taken.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO3,PO4	PSO1,PSO2
CO2	PO2,PO4,PO5	PSO1
CO3	PO2,PO5	PSO1,PSO2
CO4	PO2,PO4,PO5	PSO2,PSO2

Additive Manufacturing [3-0-0]3

Sub Code:IAR2E402 **CIE:** 50% Marks

Hrs/Week: 03 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**100

Total Hrs: 39

Course Prerequisites: NIL

Course Outcomes: After the successful completion of this course, the student will be able to:

1. Explain the importance and growth of Rapid Prototyping Techniques.
2. Differentiate and describe the operation, applications and advantages of Stereo lithography, selective Laser sintering and fused deposition modeling.
3. Analyze solid ground curing and laminated object manufacturing processes and their working.
4. Able to evaluate different Concept Modelers and recommend different tooling requirements for Rapid Prototyping.

Course Content

Module I: Introduction: Need for the compression in product development, Growth of RP industry, and classification of RP systems.

Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation

SLE: Application of stereo lithography **7 hrs**

ModuleII: Selective Laser Sintering and Fusion Deposition Modeling: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Principle of Fusion deposition modeling, Process parameter,

SLE: Fused deposition modeling applications **8 hrs**

Module III: Solid Ground Curing: Principle of operation

Laminated Object Manufacturing: Principle of operation, Process details, Machine details

SLE: LOM materials. **8 hrs**

Module IV: Concepts Modelers: Principle, Thermal jet printer, Sander's model market,.GenisysXs printer JP system 5

SLE: 3-D printer **8 hrs**

Module V: Rapid Tooling: Indirect Rapid tooling -Silicone rubber tooling –Aluminum filled epoxy tooling Spray metal tooling, 3Q keltool, etcDirect Rapid Tooling Direct. AIM, Quick cast process, Copper polyamide, DMILS, Prometal, Sand casting tooling, Laminate tooling,soft Tooling vs. hard

RP Process Optimization: factors influencing accuracy. Data preparation errors, Partbuilding errors, Error in finishing,

SLE: Selection of part build orientation for SL and SLS process **8hrs**

Text Books:

1. Pham D.T. &Dimov S.S "Rapid Manufacturing" Springer London 2011.

Reference Books:

1. Terry Wohlers "Wohler's Report 2000" Wohler's Association 2000.
2. Paul F. Jacobs: "Stereo lithography and other RP & M Technologies", SME, NY 1996,Springer

Assessment Methods:

Written Tests (Test, Mid Semester Exam & Make Up Test) are Evaluated for 25 Marks each. Out of best of two is considered to compute CIE.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO3,PO4,PO5	PSO1
CO2	PO3,PO5	PSO1
CO3	PO5	PSO2
CO4	PO1,PO3,PO5	PSO2

Mathematical Approach to Robotic Manipulators [3-0-0]3

Sub Code: IAR2E403 **CIE:** 50% Marks

Hrs/Week: 03 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**100

Total Hrs: 39

Course Prerequisites: None

Course Outcome:

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

1. Describe &explain the concepts of multi-fingered hands and dexterous manipulation, open chain manipulators using Lagrange's equations.
2. Apply the rigid body transformations and lay basics of kinematics for redundant and parallel manipulators.
3. Demonstrate grasping using grasp planning and force closure analysis.
4. Solve simple problems on redundant and non manipulable systems using Kinematics and statics of Tendon actuation.

Course Content

Module I:

Introduction: Brief History, Multi-fingered Hands and Dexterous Manipulation.

SLE: Applications **6 hrs**

Module II:

Rigid Body Motion: Rigid Body Transformations, Rotational Motion in R^3Rigid Motion in R^3,and Velocity of a Rigid Body, Wrenches and Reciprocal Screws.

Manipulator Kinematics: Introduction, Forward Kinematics, Inverse Kinematics, theManipulatorJacobian.

SLE: Redundant and Parallel Manipulators. **08 hrs**

Module III:

Robot Dynamics and Control: Introduction, Lagrange's Equations, and Dynamics of Open-Chain Manipulators, Lyapunov Stability Theory, Control of Constrained Manipulators.

SLE: Position Control and Trajectory Tracking **08hrs**

Module IV:

Multifingured Hand Kinematics: Introduction to Grasping, Force-Closure, Grasp Planning,Grasp Constraints.

SLE: Rolling Contact Kinematics **8 hrs**

Module V:

Hand Dynamics and Control: Lagrange's Equations with Constraints, Robot Hand Dynamics,Redundant and Nonmanipulable Robot Systems, Kinematics and Statics of Tendon Actuation,

SLE: Control of Robot Hands **9 hrs**

Text books:

1. A Mathematical Introduction to Robotic Manipulations- Richard M. Murray, Zexiang Li, S. Shankar Sastry CRC Press.Inc. 1st edition, 1994.

2. Dynamics and Control of Robot Manipulators-M. W. Spong and M. Vidyasagar. John Wile, 1st edition, 1989.

References:

1. Robot Analysis and Control-H. Asada and J.J.Slotine, Springer-Verlag, 1st edition, 1986.

2. Mechanism Design: Analysis and Synthesis-A.G. Erdman and G.N. Sandor, Prentice-Hall, 4th edition, 2001.

3. Fundamentals for Control of Robotic Manipulators- A.J. Koivo, Wiley, 1st edition, 1989.

4. Robotics, control vision and intelligence-Fu, Lee and Gonzalez. McGraw-Hill International, 1st edition, 2011.

Assessment Methods:

Written Tests (Test 1,2& 3) are Evaluated for 25 Marks each out of which sum of best two for 50 marks are taken.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO3	PSO1
CO2	PO3,PO4,PO5	PSO1
CO3	PO3,PO4,PO5	PSO1
CO4	PO1,PO2,PO5	PSO1

Industry Driven Elective-1

Advanced Embedded Systems [2-0-0]2

Sub Code: IAR2I01 **CIE:** 50% Marks

Hrs/Week: 02 **SEE:** 50% Marks

SEE Hrs: 2Hrs **Max.Marks:**50

Total: 26Hrs

Course Outcomes:

1. Demonstrate the knowledge on basic hardware components and their selection methodsbased on the characteristics and attributes of an embedded system.
2. Explain the hardware software co-design and firmware design approaches.
3. Explain the architectural features of ARM CORTEX M3 microcontroller including interrupts and exceptions. Demonstrate a comprehensive understanding of the instruction sets, assembly basics and memory mapping of ARM CORTEX M3.

Course Contents

Module I

Embedded System: Embedded vs General computing system, classification, application and purpose of ES. Core of an Embedded System, Memory, Sensors, Actuators, LED, Optocoupler, Communication Interface, Reset circuits, RTC, WDT

SLE: Characteristics and Quality Attributes of Embedded Systems. **7 hrs**

Module-II

Hardware Software Co-Design, embedded firmware design approaches, computational models, embedded firmware development languages, Integration and testing of Embedded Hardware and firmware, Components in embedded system development environment (IDE), Files generated during compilation, simulators.

SLE: Emulators and debugging. **9 Hrs**

Module-III

ARM-32 bit Microcontroller: Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence

Instruction Sets: Assembly basics, Instruction list and description, useful instructions, Memory Systems, Memory maps, Cortex M3 implementation overview,

SLE: pipeline and bus interface**.** **10Hrs**

References:

1. **K. V. Shibu**, "Introduction to embedded systems", TMH education Pvt. Ltd. 2009.
2. **Joseph Yiu**, “The Definitive Guide to the ARM Cortex-M3”, 2nd edn, Newnes, (Elsevier), 2010.
3. **James K. Peckol**, "Embedded systems- A contemporary design tool", John Wiley, 2008.

Assessment Methods:

Test 1and Test 2 for 25 marks each, out of which best of one is considered best of one for 50 marks are taken.

Mapping of CO’s to PO’s and PSO’S:

Course Outcomes	Programme Outcomes that are satisfied by the CO’s	Programme Specific Outcomes that are satisfied by the CO’s
CO1	PO1,PO2,PO4	PSO1,PSO2
CO2	PO1,PO3,PO5	PSO1,PSO2
CO3	PO1,PO4,PO5	PSO1,PSO2

Industry Driven Elective-2

Application of LabVIEW in Automation [2-0-0]2

Sub Code: IAR2I02 **CIE:** 50% Marks

Hrs/Week: 02 **SEE:** 50% Marks

SEE Hrs: 2Hrs **Max.Marks:**50

Course outcomes:

After going through this course the student will be able to

CO1: Understand the fundamentals of Virtual Instrumentation

CO2: Apply the concepts to realize the theoretical design.

CO3: Create a VI system to solve real time problems.

CO4: Analyze and evaluate the performance of Virtual System.

Course Contents

Module I

Fundamentals of Virtual Instrumentation: Historical perspective, advantages, blocks diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, comparison with conventional programming.

Software Overview: Lab VIEW , Graphical user interfaces - Controls and Indicators Data types - Data flow programming - Editing - Debugging and Running Virtual instrument -Graphical programming pallets - and their configuration VIs and

SLE:sub-Vis Typical examples-Vis **7hrs**

Module II

Programming Structure: FOR loops, WHILE loop, CASE structure, formula node, Sequence structures

Introduction to Arrays and Clusters: Array operations Cluster Functions, Graphs and charts, local and global variables.

File Input/Output: Introduction, File Formats, File I/O Functions, Sample Vis to Demonstrate File WRITE and READ Function. **String Handling:** Introduction, String Functions

SLE: LabVIEW String Formats Typical examples. **10 Hrs**

Module III

Basics of Data Acquisition: Introduction to data acquisition Classification ofSignals, Analog Interfacing Connecting signal to board, Analog Input/outputtechniques digital I/O.

DAQ Hardware configuration: Introduction, Measurement and AutomationExplorer, DAQ Assistants, Analysis Assistants, Instrument Assistant.

Interfacing Instruments: GPIB and RS232: Introduction, RS232 Vs. GPIB, Handshaking, GPIB Interfacing

SLE: Standard commands for ProgrammableInstruments, VISA**.** **9 hrs**

Reference Books:

1. Sanjay Gupta & Joseph John**,** Virtual Instrumentation Using Lab View, Tata McGraw Hill Publisher Ltd. New Delhi, 2nd Edition, 2010, ISBN : 978-0070700284

2. Lisa. K. Wills**, "**LabVIEW for Everyone**"** Prentice Hall of India, 2nd Edition, 2008, ISBN : 978-0132681940

3. Garry Johnson, Richard Jennings, LabVIEW Graphical Programming, McGraw Hill Professional, 4thEdition , 2006 ,ISBN: 978-1259005336.

4. Jovitha Jerome, "Virtual instrumentation Using LabVIEW", PHI Learning Pvt.Ltd., 4th Edition, 2010, ISBN: 978-8120340305.

Assessment Methods:

Test 1and Test 2 for 25 marks each, out of which best of one for 50 marks are taken

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO2,PO3,PO4	PSO1,PSO2
CO2	PO1,PO3,PO5	PSO1,PSO2
CO3	PO1,PO4,PO5	PSO1,PSO2

Industry Driven Elective-3

Python Programming for Automation [2-0-0]2

Sub Code: IAR2I03 **CIE:** 50% Marks

Hrs/Week: 02 **SEE:** 50% Marks

SEE Hrs: 2Hrs **Max.Marks:**50

Total: 26Hrs

Course Outcomes:

1. Explanation of hardware architecture, inculcating the knowledge of programming
2. Brief explanation of Character matching, HTML
3. Demonstration of database table, Data modeling.

Course Contents

Module I

Introduction to Programming: Computer hardware architecture, Understanding programming, Interpreter & compiler, the building blocks of programs

Python Programming: Introduction, Variables, Expressions, Statements, Conditional execution, Iteration, Functions, Yield, Lambda, Modules, Comments, Docstrings, Exceptions

More Data Types: Strings, Files, Lists,

SLE: Dictionaries, Tuples **7 hrs**

Module II

Regular expressions: Character matching, Extracting data, Combining searching & extracting Networks & sockets: HTTP, Web scraping, Retrieving& parsing HTML, Web services, XML, JSON Object Oriented Programming: Classes, Inheritance, Overloading, Objects, Encapsulation

SLE: Object LifeCycle **9 hrs**

Module III

Databases: SQLite, Creating a database table, Data modeling, Programming with multiple tables, Three kinds of keys, Using JOIN to retrieve data, Debugging

Pythonicness& Packaging: The Zen of Python, PEP8, PEP257, Ternary Operator, Tuple Unpacking,

SLE: Main, Packages **10 hrs**

Text books:

1. Charles R. Severance - "Python for Everybody: Exploring Data Using Python 3"
2. Allen B. Downey - "Think Python: How to Think Like a Computer Scientist", 2nd Edition
3. Al Sweigart - "Automate the Boring Stuff with Python

Assessment Methods:

Test 1 and 2 are evaluated for 25 marks each, out of which of best of one for 50 marks are taken.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO2,PO3,PO4	PSO1,PSO2
CO2	PO3,PO5	PSO1,PSO2
CO3	PO2,PO4,PO5	PSO1,PSO2

Laboratory-2 [0-0-2]1

(Automation Laboratory)

Sub Code: IAR2L01 **CIE:** 50% Marks

Hrs/Week: 02 **SEE:** 50% Marks

SEE Hrs: 3Hrs **Max.Marks:**100

Course Outcomes:

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

1. Understand working principles of hydraulics, pneumatics and sensors
2. Execute SQL and R – language programs
3. Execute assembly language program

Course Contents

List of Experiments of Hydraulics, Pneumatics and Sensors

1. Design and development of 4/2 and 4/3 Direction Control Valves
2. Design and development of AND/OR/NOR of Pneumatic circuits of 3/2, 4/2 and 5/2 valves.
3. Inspection of parts using COGNEX Vision system of edge, shape, pattern fault detection using vision system.
4. Characterization of Inductive, Capacitive, Magnetic, Ultrasonic and optical sensors.

List of Experiments of Big data Analytics of Automation

1. Hands on session on SQL – Data Definition Language(DDL), Data Manipulation Language(DML) and Data Control Language(DCL)
2. Hands on session on Creation of table
3. Hands on session on Modification of Table
4. Hands on session Insertion, Deletion, Selection operations
5. Hands on session on the Installation and Setup of R Language
6. Hands on session on working with Vectors in R Language
7. Hands on session on R-Essential in R Language
8. Hands on session on Dataframes in R Language
9. Hands on session on Matrices in R Language
10. Hands on session on Core Programming in R Language
11. Hands on session on Strings manipulation (string package)
12. Hands on session on Writing functions and best practices
13. Hands on Session on Debugging and error handling

Lab Experiments of Microprocessors and Microcontrollers

Assembly Language Program:

1. To demonstrate different addressing modes
2. To transfer the data into RAM locations using direct address and in-direct address modes.
3. To perform simple Arithmetic and Logical operations
4. To interface Analogue to Digital and Digital to Analogue converter.

Assessment Methods:

CIE	SEE
25	25

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO3,PO4	PSO1
CO2	PO1,PO3,PO4,PO5	PSO1,PSO2
CO3	PO1,PO3,PO5	PSO1

Seminar [0-0-0]1 credits

Sub Code: IAR3C02 **SEE:** 50 Marks

Course Outcomes:

CO1: Understanding the importance of literature survey for research and development

CO2: Formulating the problem statement through literature survey

CO3: Report preparation and presentation of the survey

Guidelines for Seminar Presentation:

1) This is a One-credit course aimed at teaching third semester M.Tech students of Industrial Automation &Robotics in developing critical and analytical thinking skills.
2) Each individual student has to choose a Literature paper / topic related cuttingedge technologiesof Automation & Robotics domain. Two students will not be allowed to present on the same topic/paper.
3) A detailed literature review of a specific research problem. This can include: background related to the problem, categorization of approaches, specific approaches,methodologies etc.
4) A research problem with well-identified solution and partial results, based on your own work.
5) The student must inform their respective guides of their selected paper/topic well in advance.
6) Students are required to meet their respective guides and communicate regarding seminar periodically.
7) Each student is allotted around 15 to 20 minutes for presentations and 5 minutes for Question & Answers.
8) Marks will be allotted based on technical content, relevancy to the topic, organization of power point presentations, Report, clarity of delivery and ability to answer questions from examiners.
9) A brief seminar report (Hardcopy) should be presented with department format during the time of presentations by incorporating all the suggestions from respective guides.
10) Make sure that the Department certificate in your report is signed by your guide with date before you make the final submission of the report.

Mapping of CO's to PO's and PSO'S:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO4	
CO2	PO2,PO3	PSO2
CO3	PO2,PO3,PO4	PSO2

Internship [0-0-0]5 credits

Sub Code: IAR3C03 **SEE:** 50 Marks

Course Outcomes:

CO1: Exposure towards the automation industry sector and understanding of automation industry

CO2: Providing solution to the industrial problems.

CO3: Presentation of the work and report preparation.

Guidelines for Internship:

Regarding the Internship program, the following guidelines are brought to the notice of the students of M.Tech Industrial Automation & Robotics:

1) As per the presentCurriculum requirements of Visvesvaraya Technological University (VTU)/AICTE, the students of Post Graduate programs are compulsorily required to undergo internship training in a premier industry / institute during their third semester.
2) It is stipulated that the internship period be a minimum of 8 weeks.
3) The internship can be carried out in any industry/Research and Development Organization/Research Institute/ Educational institute of repute.
4) During internship program each student are required to take up any case studies or assignments given by the external supervisor and work the same.
5) Students are required to report all the activities of internship on weekly basis either physically or by communicating through email to respective guides positively.
6) Each student is allotted 15 to 20 minutes for presentations and 5 minutes for Question & Answers.
7) Marks will be allotted based on technical content, relevancy to the topic, organization of power point presentations, Report, clarity of delivery and ability to answer questions, queries from examiners.
8) Students are instructed to collect internship completion certificate or reliving certificate at the end of 8 weeks positively and the copy should be incorporated in final draft copies.
9) A brief internship report (Hardcopy) should be submitted with department format during the time of presentations by incorporating all the suggestions from respective guides.
10) Make sure that the Department certificate in your internship report is signed by your guide with date before you make the final submission of the report.

Course Outcomes	Programme Outcomes that are satisfied by the CO's	Programme Specific Outcomes that are satisfied by the CO's
CO1	PO1,PO3	PSO1
CO2	PO1,PO5,PO4	PSO1,PSO2
CO3	PO2	

Dissertation (Phase 1)
Project Work Preliminary (8 credits)

Sub. Code: IAR3C04 SEE: 50 Marks

Course Outcomes (COs):

At the end of the course, students will demonstrate the ability to:

1. Conceive a problem statement either from rigorous literature survey or from the requirements raised by external entity during the internship work.
2. Analyze the problem critically
3. Write the document report in form of .doc and .ppt.
4. Present the work done and initial report submission.

Guidelines: As per the VTU directives, after 8 weeks of Internship works, immediately students have to start the dissertation work. The work must be evaluated in two phases i.e. Phase – I: after end of 3rd semester and Phase – II: end of 4th semester.

The dissertation work may be carried out preferably in industry, department's laboratories and external Research Institutes.

After multiple interactions with guide and based on comprehensive literature survey, the student shall identify the domain and define dissertation objectives. The referred literature should preferably include National and International journals published in International publishers like IEEE/Springer/Science Direct/ACS in the domain areas. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and phase wise work distribution and submit the initial project phase 1 report by the end of 3rd semester.

Phase – I Deliverables: A detailed report comprising of summary of literature survey, detailed objectives, project specifications, conceptual design, proof of concept/functionality, initial results, a record of continuous progress, PowerPoint presentation.

Phase – I Evaluation: An expert committee comprising of guide, course coordinator of respective specialization shall assess the progress/performance of the student based on report, presentation and Q & A.

Mapping of COs to POs:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	PSO's
CO 1	PO1, PO2	PSO 2
CO 2	PO1, PO3, PO4	PSO 1
CO 3	PO2, PO3, PO5	PSO 2
CO 4	PO2, PO4, PO5	PSO 2

Dissertation (Phase 2)
Project Work Phase II (15 credits)

Sub. Code: IAR4C01 CIE: 50 Marks
SEE: 100 Marks

Course Outcomes (COs):

At the end of the course, students will demonstrate the ability to:

1. Design, implement and test the hypothesis proposed in Phase 1, in order to solve the conceived problem.
2. Interpret and analyze the results/findings.
3. Write the final Project report cum Master Thesis.
4. Present the work done as a power point.
5. Publish the research work in journals/conferences of repute contributing to growth of Science/technology in the domain.

Guidelines:

As per the VTU directives, after the phase 1, 4th semester is fully focused on the Phase 2 dissertation work. The work must be evaluated for Phase III: end of 4th semester. The dissertation work may be carried out preferably in industries, department's laboratories, external Research Institutes or Centers.

After multiple interactions with guide and based on comprehensive literature survey, the student shall identify the domain and define dissertation objectives. The referred literature should preferably include National and International journals published in International publishers like IEEE/Springer/Science Direct/ACS in the domain areas. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation of the results/ideas from Phase I work and submit the final project phase II report by the end of 4th semester. During phase – II, student is expected to focused on design, implementation and testing of the proposed idea as per the schedule. Accomplished results should be published in terms of research papers in peer reputed journals.

Phase – II Deliverables: A dissertation report as per the specified format of the NIE/department, developed prototype system (if any), a record of continuous progress work.

Phase – II Evaluation: Guide along with appointed external examiner shall assess the work done and knowledge acquired by the student based on report, presentation and Q & A.
In case of unsatisfactory performance, committee may recommend for extension or repeating the work.

Mapping of COs to POs:

Course Outcomes	Programme Outcomes that are satisfied by the CO's	PSO's
CO 1	PO1, PO3	PSO 2
CO 2	PO1, PO2, PO4	PSO 1
CO 3	PO2, PO4, PO5	PSO 2
CO 4	PO2, PO4, PO5	PSO 2
CO 5	PO1, PO2, PO5	PSO 2