



VIGNAN'S

Foundation for Science, Technology & Research

(Deemed to be **UNIVERSITY**)

-Estd. u/s 3 of UGC Act 1956

R22 Academic Regulations

In Compliance with NEP 2020



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PREFACE

'You are born to Blossom' – What an inspiring title the book authored by APJ Abdul Kalam and Arun K Tiwari carries. The journey to blossom has got to be heralded by education. The purpose of education is to ensure that the 'Life Blossoms'. Earning a degree and getting a placement should be the just happening things, and should not become the only celebrated goals for education. In the book cited above, Honourable Kalam, Former President of India, underscores that "The scheme of civil society depends on Educating young people to become enlightened citizens and adults who are responsible, thoughtful and enterprising"

VIGNAN aims to seed these concepts in every learner who transits through this temple of learning. The doctrine of VIGNAN entitled R-22 contains the principles of policies laid down by the University, to realize the spirit of "Blossoming the lives" providing a foundation-strong professional education on the ethos of 'Creative learning for Critical thinking and Critically analysing for Creative decision making'. Certainly, our University is one of the earliest Universities, in fact the University is a trend setting one in completely internalising the concepts of the policies brought out in National Education Policy (New Educational Policy) NEP-2020, and inculcating the spirit in R-22. The R-22 document articulates the Academic Regulations of the University, which is being presented now and shall be in force with immediate effect from the academic year 2022-23, not only for those who have joined in 2022, also the aspirants of 2021-22 are enabled into the navigation.

R-22 presents a novel design for the academic pursuit, making an exploratory cross disciplinary traversal for a learner who should find learning both holistic and experiential. The learner is ensured to enjoy the continuity in learning and the learner is supported to align and realign, enroute utilising the benefits of constructive feedbacks that s/he receives because of continuous assessment. S/he will be empowered to enjoy the opportunities to explore, experiment and experience.

R-22 eliminates the melancholy of examinations. The expected severity of breakdown due to the anxiety of examination system is replaced by an affectionate assessment system, increasing the effectiveness in accomplishing the outcomes.

In brief, NEP-2020 compliant revised academic regulation of the University – the R-22, is VIGNAN's commitment to alleviate the acuteness in the present educational practices. It intends to provide a strategic solution to the critical observation made by Bharat ratna awardee, Professor. CNR Rao – "India has exam system, not education system. When will young people stop taking exams and do something worthwhile?" (Thought for the Day, Times of India 13.08.2022)

Here is R-22, which assures that the learners at VIGNAN are bound to do something worthwhile – very much worthwhile.

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* Programme will be offered based on satisfactory strength of students willing to register, after receiving the formal AICTE approval.

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Academic Regulations, Curriculum and Course Contents

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EXECUTIVE ABSTRACT

R22 - Academic regulations, Curriculum and course contents, is an articulation of the VFSTR deemed to be University's commitment towards NEP-2020, with a view that it enables student(s) to maintain the spirit of continuous learning and continuous assessment to replace the normal tendency of preparing just before a test or an examination. The proposed framework accomplishes multi-disciplinary holistic education, continuous assessment along with multiple honorable exit options if a student falls short to complete the requirements to earn the degree within the stipulated period including the permissible spill over period.

R22 is oriented towards holistic education at the postgraduate level that includes integrated and rigorous exposure to professional domains, as well as sufficient flexibility in curricular structures that allow students to choose electives from the wide choice of courses. Such holistic and diverse education will assist the candidate in transforming into all-rounded persons. Similarly, in line with NEP-2020, more weight is given to continuous/ formative assessment, in the frame work of an Integrated learning model comprising Learning – Thinking – Understanding – Skilling – Applying – Creating. Emphasis on continuous formative assessment with a creative summative assessment will facilitate the candidate to "Move away from high stake examinations – towards more continuous and comprehensive evaluation".

The M.Tech. degree offered will be for two years' (4 semesters) duration with lateral exit options within this period, with suitable certifications that will enable the candidate to have a professional career and as well as serves as a reminder to return and update his / her qualification in the future. In line with NEP-2020, following one year of study and the completion of the required credits, an Engineering PG Diploma degree will be conferred. However, the intention of the learners is not to join for the award of the PG diploma with lateral exit, but to acquire a M.Tech. degree.

Salient features of the regulation

- Continuous learning
- Continuous assessment
- Add-on certification
- Honorable exit option
- Onward Continuation to Ph.D. Program
- Sabbatical Semester Drop option to pursue innovation, incubation, entrepreneurial and advanced exploratory activities and subsequent re-entry

1 INTRODUCTION

This document contains the academic regulations, scheme of assessments, curriculum, detailed syllabi, course contents with text / reference books recommended, course outcomes, skills acquired and the projects / assignments that are to be performed for each course for the conduct of 2-year M.Tech. degree programmes. The various M.Tech. degree programmes under different schools in VFSTR are as listed below. The character codes indicated in paranthesis are their branch disciplinary code.

I. School of Agriculture & Food Technology

- Food Processing Technology (FT)
- Farm Machinery (FM)



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- II. **School of Biotechnology & Pharmaceutical Sciences**
 - Biotechnology (BT)
- III. **School of Computing & Informatics**
 - Computer Science & Engineering (CSE)
- IV. **School of Conventional Engineering**
 - Structural Engineering(SE)
 - Machine Design (MD)
- V. **School of Electrical, Electronics & Communication Engineering**
 - Embedded Systems (ES)
 - VLSI (VLSI)
 - Power Electronics and Drives (PED)

1.1 Definition

For the purpose of R22 regulation, definitions as follows shall apply:

- **“Degree”** shall refer to the M.Tech. Degree Program.
- **“Course”** shall refer to such Course(s) for which a student shall earn Credits after due assessment as per the laid provisions. Project is also treated as a Course.
- **“Academic activities”** shall refer to the activities like Lecture (Physical Lecture Session), Tutorial (Participatory discussion / Self-Study / Desk Work / Quiz / Seminar Presentation, etc activities that make the student absorb & assimilate, the delivered contents effectively) and Practical / Practice sessions (includes Hands on Experience / Lab experiments / Field Studies / Case Studies etc activities that enable the student to acquire the requisite skill).
- **“Continuous Assessment”** shall refer to the assessment of the student spread over the entire semester on the various constituent components of the prescribed course.
- **“Semester”** shall refer to a period covering the two assessment periods viz Formative and Summative Assessment period. A semester would generally be spread over twenty weeks.
- **“Course Drop”** shall refer to a student having to undertake a repeat of the Course(s) not being able to complete the Credit requirements of the Course(s), under the conditions stipulated in the regulation.
- **“Supplementary Examinations”** shall refer to the examination(s) conducted to allow the student to appear in the un-cleared Semester - End summative assessment component.
- **“Blank Semester”** shall refer to a Semester in which a student either does not register for any course at the beginning of the Semester OR chooses to DROP all courses OR is so compelled to DROP all the courses, as the case may be.
- **“Semester Drop”** shall refer to availing a blank semester. However, if drop is availed to pursue a creative extension activity, then it is defined as **semester sabbatical**.
- **“Spill Over Semester”** shall refer to the additional semester(s) beyond the completion of prescribed normal semesters.
- **“AAA Section”** shall refer to the Academics, Assessment and Awards Section of the Institute.
- **“Attendance”** refers to the Physical personal presence in an academic activity session.
- **“Summer Semester”** refers to a Semester that is scheduled to be held during the intervening period of Even and Odd Semester (*i.e.* Summer Vacation period).
- **“Themes”** refer to the courses offered in a particular stream other than offered by the regular departments, for example NCC, Entrepreneurship, Fitness and Living, etc.
- **“School”** refers to a division of institute dealing with two or more specific areas of discipline / study comprising of the departments related with exclusive emphasis on trans-disciplinary research.
- **“Department”** refers to a division of institute dealing with a specific area of discipline / study.



- **“HoD”** refers to the Head of the respective Department, where the student is enrolled for his / her Branch of Study.
- **“Center”** refers to a structured unit within the school / department established with the purpose to carry out advanced research.
- **“Grade Point”** refers to the quantification of the performance of a candidate in a particular course as defined herein.
- **“SGPA”** refers to the Semester Grade Point Average and is calculated as detailed in the regulations subsequently.
- **“CGPA”** refers to the Cumulative Grade Point Average and is calculated as detailed in the regulations subsequently.
- **“Division”** refers to the Division awarded to the student as per the mechanism detailed in the regulations subsequently.
- **“Internship”** refers to onsite Practical Training offered by reputed companies / Institutions, in India or abroad. To be undertaken with (or seeking) prior approval of the respective HoD.
- **“Project”** refers to a course executed by a candidate on a specific research problem at VFSTR / any organization of repute. To be undertaken with (or seeking) prior approval of the respective HoD.
- **“Credit equivalence and credit transfer committee”** refers to the committee designated to look into for credit equivalence and credit transfer.
- **“Honorable Exit Option”** refers to the Exit Options available to students, when they are unable to complete the prescribed two-year M.Tech. Degree program in four successive years.

1.2 Academic Administration

The academic programmes of VFSTR are governed by the rules and regulations approved by the Academic Council from time to time. The various academic activities are conducted following a fixed time schedule duly approved by the Academic Council in line with the AICTE / UGC regulations. The academic activities of VFSTR are followed meticulously as specified in the academic calendar as approved by the Academic Council. This academic calendar is shared with all the stake holders well before the beginning of the respective academic year. The curriculum and the course contents of all the programmes are discussed by the respective Board of Studies (BoS), analyzed and recommended for implementation. The Academic Council, being the highest statutory body, chaired by the Vice-Chancellor, meets at least twice or thrice a year and discusses, suggests and approves all the important academic matters related to curriculum and course contents in particular including the recommendations of BoS.

The intended revision in regulations (R22) was in principle accepted and recommended by the Academic Council in its 32nd meeting on 10-12-2022. Subsequently respective Board of Studies brought necessary recommendations accordingly, which were duly placed before the Academic Council in its 33rd meeting on 17-6-2023.

1.3 Program Duration

For the branch disciplines listed in section (1), the regular courses including theory and practical are offered over a period of two years in four semesters. The normal duration to complete the M.Tech. program is two years. However, a student can avail the benefit of spill over period for 2 years, that is the maximum duration of four years can be availed by a candidate to complete the M.Tech. programme in a slower pace if he / she desires. The candidate failing to complete the requirements will be considered for the honorable exit as applicable

1.4 Courses and Credits

The term course is used in a broader sense to refer to so called papers such as ‘theory subject’, ‘laboratory’, ‘inter-departmental project’, ‘major-project’ etc. A course can be of theoretical and / or of practical nature, and certain number of credits are allotted to it depending on the

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number of hours of instruction per semester. For a course offered in a semester, one hour of lecture (L) instructions carried out in a week is considered equivalent to one credit, whereas two hours of practical (P) sessions done in a week are considered equivalent to one credit. Depending on the course two hours of tutorial (T) sessions may be considered equivalent to one credit. A student earns these credits when he / she successfully completes the course.

1.4.1 Content Delivery of a Course

Content delivery of a Course in the M.Tech. Degree Program shall be through, either or all, of the following methods:

- i. **Lecture** - refers to Lecture Session(s) through classroom contact session wherein students will learn by listening. Denoted by "L".
- ii. **Tutorial** - refers to transaction(s) consisting of Participatory discussion / Self-study / Desk work / Brief presentations by students along with such other novel methods that enable a student to efficiently & effectively absorb and assimilate the contents delivered in the lecture sessions. Denoted by "T".
- iii. **Practice** - refers to Practice / Practical sessions and it consists of Hands-on- Experience / Laboratory Experiments / Field Studies / Case Studies / Minor / Major Project, that equip the students to acquire the much required skill component. Denoted by "P".

1.5 M.Tech. Degree

All students formally and conventionally enroll for M.Tech. degree programme. They have to earn **68** credits for the award of degree as specified in the Curriculum. However, additionally he/she can opt to earn up to 12 more credits as Add-on credits, to earn the academic benefits as specified below.

1.5.1 M.Tech. with Add-on Certification

If a candidate earns add-on 12 credits in the respective discipline, then he/ she will be eligible for the award of M.Tech. in YY Engineering with Add-on Certification.

Note: The consolidated transcript will contain the credits and grade details of all courses amounting to 68 + up to 12 credits.

1.6 Composition of an Academic year

An academic year is composed of an Odd semester (20 – 22 weeks), an Even semester (20 – 22 weeks) and a Summer semester (6 – 8 weeks). The regular semester that begins in July / August is known as odd / first semester and the one that begins in December / January is known as even / second semester (Figure 1). The instructional days for a regular semester shall be a minimum of 90 working days exclusive of days earmarked for summative assessment.

YEAR OF 12 MONTHS											
1	2	3	4	5	6	7	8	9	10	11	12
July/ Aug.	Aug./ Sept.	Sept./ Oct.	Oct./ Nov.	Nov./ Dec.	Dec./ Jan.	Jan./ Feb.	Feb./ Mar.	Mar./ Apr.	Apr./ May	May/ June	June/ July
ODD SEM/ FIRST SEM					EVEN SEM/ SECOND SEM					SUMMER SEM	

Figure 1: Distribution of semesters during an Academic Year.

- 1.6.1 Before the commencement of the semester, a candidate has to pay the stipulated tuition fee and submit an application detailing the courses he / she intended to register, valid for that respective Odd / Even semester. The maximum number of credits per semester will be 25 credits inclusive add-on credits. The intended semester wise coverage will be as presented in the curriculum.



1.6.2 Summer semester is a short duration semester program that will be generally conducted during the semester break between even semester and odd semester. The students having 'R' (Repeat grade) courses may register for the course work during this semester to get a chance for successfully completing the 'R' courses. In general, supplementary assessments are conducted in the later part of the summer semester. However, the courses offered in summer semester and the number of courses a student can register are subjected to academic and administrative convenience. A student may register up to a max. of 12 credits in a summer semester.

1.6.3 Exception to the routine practice of registering for 'R' courses in summer semester, a student can register in a course offered by a visiting expert during the summer vacation which may be equivalent to a department elective or an Add-on-course. The candidates can register for such courses within the scope of 12 credits. Candidate may also avail summer semester for summer internship opportunities, which may be considered as Add-on credits.

1.7 Semester wise provisions

A student may register for a max of 25 credits per semester as prescribed or otherwise he/she may include the Repeat courses in the event of having not successfully completed a course or courses in the earlier semester. However, a student may also opt to go in a slower pace to earn the credits less than the prescribed max of 25, including even 'Dropping' a semester for special reasons.

It should be clearly underscored that a candidate should on priority register for Repeat (R) credits if any, during a regular semester, within the said scope of 25 credits; in case he / she cannot be sure of completing or could not complete the 'R' credits in Summer semester.

1.7.1 During the first two years from the date of admission to M.Tech., a candidate has to pay the semester / annual fees as prescribed irrespective of the less number of credits that he / she would register or even opt to Drop a semester.

1.7.2 If a candidate gets into spillover semester beyond two years up to a maximum of four years he / she has to pay semester fee proportional to the credits that he/ she registered in that spill over semester as prescribed from time to time.

1.7.3 A candidate has to pay additional fee proportional to the number of credits for registering in a summer semester as prescribed from time to time.

2. CURRICULUM

Each School offers different M.Tech. degree programmes and the departments concerned prescribes semester-wise curriculum encompassing different courses. Every course offered will be designated in a L-T-P structure. The theory courses comprise of L (and / or T & P hours) whereas the practical courses include instructions (T) and practical sessions (P). Amalgamation of theory courses with practical sessions is predominantly seen in this curriculum.

2.1 Distribution of credits

The overall distribution of credits for various categories of courses in the curriculum of M.Tech. programmes is represented in Table (1) as given below.

Table 1 : Credits Distribution for Various categories of courses.

Category of Courses	Credits (%)	AICTE Recommendation (%)
Professional Core	29.4	29.4
Electives	17.6	22.1
Inter disciplinary courses	8.8	7.4
Projects	44.1	41.2

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2.2 Organization of course contents

Courses offered in the program is composed of two modules covering all the course contents required for a candidate to obtain knowledge and skill. Content in each module is further distributed among two units; wherein Unit -1 contains 'Fundamentals and Broad perceptive' of the module. Unit-2 comprises of the extension / advanced topics of Unit-1 as well as necessary practice models for validation / applying the knowledge gained during L/T sessions. The modular period is about 8 weeks. The first unit in a module may be covered in 2 to 3 weeks and the second unit of the module maybe of 5 to 6 weeks (Figure 2). By the end of each module a candidate must be in a position to translate his/ her L-based knowledge into P-based skill as prescribed in the curriculum. Individual formative assessment shall be in place for each module and a single semester-end summative assessment for the course composed of both the modules.

YEAR OF 12 MONTHS											
1	2	3	4	5	6	7	8	9	10	11	12
July/ Aug.	Aug./ Sept.	Sept./ Oct.	Oct./ Nov.	Nov./ Dec.	Dec./ Jan.	Jan./ Feb.	Feb./ Mar.	Mar./ Apr.	Apr./ May	May/ June	June/ July
ODD SEM/ FIRST SEM					EVEN SEM/ SECOND SEM					SUMMER SEM	
Module- I		Module- II				Module- I		Module- II			
U1	U2	U1	U2			U1	U2	U1	U2		

Figure 2: Unit-wise distribution of course contents in a module and their mapping with Academic Calendar; U= Unit.

3. CHOICE BASED CREDIT SYSTEM

Each branch discipline of the M.Tech. programme comprises of a set of courses - professional core, electives, projects and audit courses. VFSTR offers flexibility for students to choose courses of their choice and obtain the credits satisfying the minimum credits criterion in each category as given in Table-1.

3.1 Professional Core

Professional Core courses are individualized for each programme and they are mandatory for every student opting for that branch discipline. These are designed to offer the essential fundamental knowledge and skills required for that specific programme.

3.2 Electives

A candidate has a choice to choose the elective courses. A list of elective courses are pooled together, enabling a candidate to choose the electives from a pool. There may be more than one pool in certain disciplines aligned to a specific theme. Otherwise also he/ she can exercise the choice to choose electives from across the pools. There may be courses which may not be listed under any pool, which are called 'Free elective courses'.

Elective courses offered for each programme are categorized as 'program electives' that are aimed at offering the advanced/ additional knowledge in the chosen branch discipline.

Care should be exercised while opting for program elective courses and Add-on certification courses that is a course opted as program elective should not be registered as a course under Add-on certification courses and vice versa.

Apart from 68 credits, additionally candidate has to earn 12 credits for Add-on certification. Of these 8 credits may be earned through MOOCs offered via Swayam platform. A student may also be permitted to earn more elective credits through MOOCs. This will promote self-learning and drive students towards innovative learning approaches.

To facilitate the process of acquiring the elective credits through MOOCs, VFSTR has constituted "Online course committee" at Central level with 1-2 members represented from each of the department to guide students in selection of courses and to assist them with further steps if required until completion of the courses.

3.3 Inter disciplinary courses

Courses such as Cyber security, Research Methodology & IPR and employment Orientation/ Soft skills program are offered in the first and second semester of the programme. As per UGC guidelines cyber security course is introduced as compulsory course. The M.Tech. students are encouraged to participate in research activity of both academia and industry, hence research methodology & IPR could be an important course to offer.

The 50-hour Employment Orientation Program (EOP) for M.Tech degree students is conducted with the help of in-house and invited experts. It is aimed at improving presentation skills in general and pedagogical skills in particular.

3.4 Teaching Assistantship

Candidates after undergoing Employment Orientation Programme in the first semester of the program should enroll for the 'Teaching assistantship' course during their second semester to earn 2 credits. Each candidate will assist faculty in handling a 'P-based activities' for B.Tech. students, developing teaching abilities like handling the sessions, interaction with students for clarification of doubts and assessment capabilities. The candidate performance will be assessed in the same lines.

3.5 Inter Departmental Project

These projects are designed and executed by students during the first year second semester of their program. By doing these projects, students will get an idea of how technologies or processes, prototype or working model can be developed by culmination of technologies from courses of different programs. The minimum duration of inter-departmental project during each of the semester is 90 hours including writing of project report and submission for assessment. A batch of 2-3 students from same or across the departments can take part in each of the inter-departmental projects. Performance will also be assessed in the modular framework for formative and semester-end summative with a weightage of 2 credits

3.6 Project

Students may opt for Project work in lieu of internship for two complete semesters during second year. Such students may avail research-internship support from any institution well known for research and development (R&D). They may also take up project work in VFSTR itself. Each candidate has to submit interim reports and a final report which are mandatory requirements towards the partial fulfillment of project credits requirements. It bears a weightage of 13 credits for the work executed in the third and fourth semesters totalling up to 26 credits. During the project work the student under the guidance of a faculty member(s) will involve in an innovative design / research through the application of his / her knowledge gained in various courses studied. He / she is therefore expected to present a survey of literature on the topic, work out a project plan and carry it out through experimentation / modelling / simulation / computation. Through such a project work, the student is expected to demonstrate system analysis, design, presentation and execution skills. Performance in the project will also be assessed in the modular framework for formative and summative assessments.

3.7 Internship

A student can undertake internship in lieu of project work in industry for two complete semesters during second year in lieu of major project work. It bears a weightage of 13 credits for the work executed in the third and fourth semesters totalling up to 26 credits. This is aimed at training students in solving / understanding real-life problems through application of engineering analysis, design, evaluation and creation, particularly in association with practitioners and experts in the industry. The procedures for obtaining the internship placements and allocation of the same to the students are as per University. Even during internship, a student is preferably expected to carry out a focused study on one topic / problem in consultation with the interning institute. Internship progress report should be submitted periodically and finally a detailed internship report should be submitted duly certified by a mentor from the internship institute. Performance in the internship will also be assessed in the modular framework for formative and summative assessments.

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4. ATTENDANCE

It is mandatory for the student to attend the course work in each semester as per the academic schedule of that semester. VFSTR expects 100% attendance. However, the attendance in each course shall not be less than 75 % of the aggregate of all L, T, P sessions conducted in that course.

- The attendance calculations will be periodically reviewed at the end of every 4 weeks. The details of attendance status will be shared with the parents / guardian. The final status of attendance will be reported at end of 15th week granting the advantage of the attendance for the 16th week for the purpose of attendance shortage calculations.
- The shortage of attendance may be condoned up to 10% on the ground of ill-health, social obligations, participating / representing in sports/cultural events, placement activities etc.
- Documentary evidence like medical reports and certificates issued by concerned bodies is to be produced on time as support for the attendance shortage due to ill-health. These cases are subjected to the scrutiny of a committee constituted for this purpose by the Vice-Chancellor. The decision of the committee shall be final.
- Prior approval has to be taken from the HoDs for the other types of leaves.
- The courses where the student shortage of attendance was not condoned shall be considered as 'Repeat' category courses and will be under 'R' grade in the student's semester transcript. Student should re-register for these courses during the summer semester or whenever the course is offered next time during regular semesters. These re-registrations are subjected to the regulations at the time of re-registration. In case of core courses, the same core has got to be re-registered. However, in case of an elective a candidate may exercise a choice of choosing different elective in place of 'R' graded elective.

The students who are put into 'R' grade will not be allowed to take up the summative assessment in that semester. In case due to lack and/or delay in information, if he/she appears for the summative assessment in that course, office of AAA is empowered to cancel the attended exams. The scores obtained either in formative or summative assessment will not be considered for grading.

5. ASSESSMENT

Teaching-Learning and Assessment should go hand in hand and complement each other. Continuous assessment plays a vital role to enable the student to get synchronized with the teaching-learning process. Assessment mechanism adopted in the institute is aimed at testing the learning outcomes in tune with the outcome based model of education. The focus, is thus on assessing whether the outcomes are realized by the end of the course.

The performance of a student in each course is assessed on a continuous basis during the semester through various in-semester and end-semester assessment models. The marks awarded through continuous assessment are referred to as Formative assessment marks. The marks awarded through end-semester tests are referred to as Summative assessment marks (Figure 3). Both the formative and summative assessment marks are considered for awarding the final marks and the grade point in a particular course.

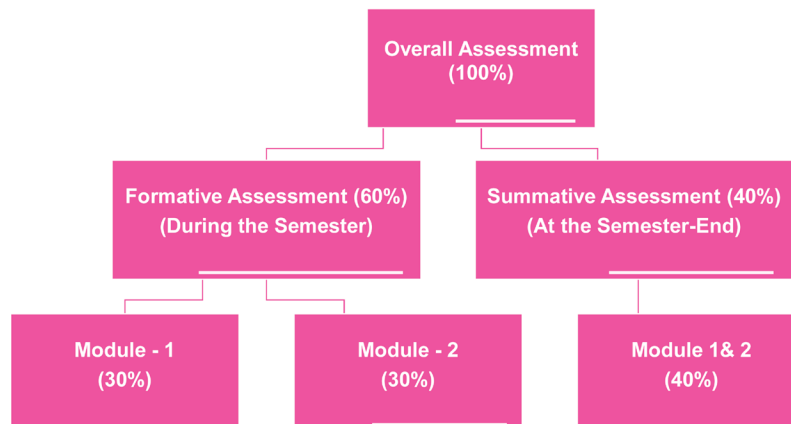


Figure 3: Categories of assessments in place for R22.



5.1 Marks distribution

For each course, the maximum sum of formative and summative assessment marks put together is 100, in the ratio of 60:40, respectively.

5.2 Qualifying criteria

To be declared successful in a course, a student must secure at least a grade 4.5 in a scale of 10 based on the total maximum marks which is inclusive of formative and summative assessment. The students should also get 40% from the maximum marks allotted for formative and summative assessments individually.

The hierarchy of qualifying criteria is as follows:

- Attendance compliance should be 75% or within condonable range; else the candidate is put into 'R' grade.
- In formative assessment, a candidate should secure a minimum of 40% i.e. 24 marks out of 60; else the candidate is put into 'R' grade.
- In summative assessment, a candidate should secure a minimum of 40% i.e. 16 marks out of 40; else the candidate is put into 'I' (Incomplete) grade.
- Collectively the candidate should secure a min. grade of 4.5 in a scale of 10 after relative grading; else the candidate has to choose either 'R' or 'I' grade duly being counselled.
- Every semester, candidate should score a min. of 5 Semester Grade Point Average (SGPA) in every semester individually with the successfully completed courses. In case a candidate fails to score the min. SGPA, then he / she shall voluntarily drop a few Courses to ensure a SGPA of 5. He / she after duly counselled has to choose either 'R' or 'I' grade for the dropped courses.

The candidates with 'R' grade should re-register for 'R' courses either in Summer semester or in a regular semester as and when the courses are offered. The candidates in 'I' grade are allowed to appear for supplementary summative assessment whenever the semester-end assessments are conducted.

To assess special projects / courses, not fitting into the categories described here, a suitable assessment procedure will be evolved in consultation with experts of that area and adjudicated by the committee constituted for that purpose. The decision given by the committee will be final. The appended assessment scheme shall be announced by the course coordinator during the commencement of course.

YEAR OF 12 MONTHS												
1	2	3	4	5	6	7	8	9	10	11	12	
July/ Aug.	Aug./ Sept.	Sept./ Oct.	Oct./ Nov.	Nov./ Dec.	Dec./ Jan.	Jan./ Feb.	Feb./ Mar.	Mar./ Apr.	Apr./ May	May/ June	June/ July	
ODD SEM/ FIRST SEM				EVEN SEM/ SECOND SEM				SUMMER SEM				
Module- I		Module- II			Module- I		Module- II					
U1	U2	U1	U2		U1	U2	U1	U2				
Formative Assessment				SA	Formative Assessment				SA			

Figure 4: Schedules of formative and summative assessments in line with Academic calendar. SA = Summative assessment.

5.3 L-based courses integrated with P/T

5.3.1 Formative Assessment

The scheme of formative assessment is designed to promote the continuous learning. Scheme consists of assessments planned at institute level and assessment that may be scheduled by



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the course instructor (Figure 4). Institute level assessments shall be scheduled by the office of AAA. Respective Faculty Member(s) shall declare the schedule of Continuous Laboratory Assessments (CLA), Quiz, Tutorials, Assignments, Seminars, Discussions, etc. Some of the components may also however take place in an unscheduled manner like Surprise Tests. However, students shall be made aware of the assessment modalities that are going to be followed in a course by the faculty, under information to the HoD.

To monitor the progress of students, continuous assessment comprising of five targets (T1, T2, T3, T4 and T5) is advocated in each module for a maximum of 60 marks. For a class, formative assessment commences by the announcement of module bank containing 10 problems for each module in a course. Nature of problems in the module bank shall be at the level of creative / exploratory / design / thought provoking covering the complete syllabus of a module at advanced / challenging level.

The purpose of creating module bank of 10 problems is to assign one problem to each student or to a batches of 2 members. The batches are composed of randomly picked up candidates. These batches remain same for all courses and also for the P-sessions in the courses in that semester and are created in the beginning of that semester.

The purpose of assigning one problem to two batches is to create a healthy competitive spirit between the two batches.

The modality of evaluation of five targets is listed here under:

- a) **T1:** During 5th or 6th week of each module a classroom test shall be conducted. T1 consists of two parts: A and B.

Part A consists of one random problem from the module bank and varies from batch to batch. All the questions in the module bank shall be distributed among students and students shall know the question to be answered only on the day of test in the examination hall.

Part B consists of one common problem at fairly application/ advanced level (**not at all prior notified**) from outside the module bank for all the students.

T1 shall be paper based and proctored test for a period of 60 min (maximum) which shall be assessed for 30 marks and downscaled to 10 marks.

For the students who for justifiable reasons could not attend the classroom test on the scheduled day, a re-test maybe conducted. However, Part-B will contain a new question and Part-B will have higher weightage than part-A or full weightage could even be allotted for Part-B in such an event

- b) **T2:** Immediately follows T1. Students in a specified batch who now have received the same question during T1 will work further on that problem for T2.

T2 is primarily an extension of problem received in T1 for carrying out validation study: Case studies / Simulations / Experimentation. Each batch shall interact with the course instructor to finalize the nature of validation and expected to complete the exercise within 10 to 15 days after T1.

Course instructor should ensure assigning a different case study / a different scope for validation study for each batch in case the same problem is assigned to two batches.

Course instructor shall assess every student in a batch for a max. of 10 marks based on his observation, interaction and/or reviewing (based on at least two reviews).

- c) **T3:** T3 shall be conducted during the last week of each module. Student batches are expected to submit a report, clearly documenting the work executed during T2. The report should be in IEEE / APA format and additionally a voice in-built PPT should be prepared and submitted.

The report and presentation shall be assessed by the course instructor for 10 marks for every student. In certain cases, a course instructor can call a batch for a physical presentation also.



- d) **T4:** T4 is a comprehensive module test, conducted for 30 min. comprising of 20 multiple choice questions (MCQs) covering the holistic content of module. T4 shall be evaluated for a max. of 10 marks @ ½ mark for each question. T4 will be conducted in ON-LINE mode.

There shall be two tests in each course in a day and the best performance of the tests shall be considered for awarding the marks.

Two sets of question papers each containing 20 questions should be set. The theme of the questions could be similar across the sets. When the test is administered online, every student receives the questions in shuffled sequence and also the choices in shuffled sequence. Therefore, the choice like both 'a' & 'b' above, neither 'a' nor 'b', all the three a, b, c will not be set.

- e) **T5:** T5 assessment is based on Practice or Tutorial assignments. Implementation, Report presentation and Discussion shall happen in a continuous mode throughout the module period.

At least 4 such continuous lab practice assessments (CLPA) / assignments per module shall be conducted by course instructor. The marks will be @ 5 marks per assignment totalling up to 20 per module.

- f) The scores of the targets are to be normally announced within three working days on completion of the assessment and the performance is to be discussed in the class.
- g) The total marks per module is 60 - T1 (out of 10), T2 (out of 10), T3 (out of 10), T4 (out of 10) and T5 (out of 20).
- h) Total marks for both the modules from formative assessment will be added up to 120, which will be **suitably mapped down** to a max. of 60 marks. The mapping policy should be decided by the lead instructor / instructors in consultation with the HoD. The mapping policy should be shared with Dean AAA for the purpose of documentation.
- i) The marks scored in Module-1 for a max. of 60 should be entered / submitted latest by 9th week and of Module-2 latest by 17th week of the semester. Consolidated score for a max. of 120 **suitably mapped down** to a max. of 60 marks should be submitted latest by 18th week of semester enabling the declaration of 'R'- grade before the commencement of summative assessment.
- j) A candidate put under 'R'- grade will not be permitted to take up the summative assessment.

5.3.2 Summative Assessment

- a) An instructor may choose one of the two formats for conducting summative assessment for L-based courses integrated with T/P.
- 15 + 25 marks format or 20 + 20 marks format (following b, c, d below).
 - 40 marks format (following c, d below).
- b) **If summative assessment is in two parts format:**
- Part-I will be the assessment of capstone project which is pre-assigned during the module-2 period or will be the exploratory review assessment of all lab practice assignments.
 - Part-II will be based on a written examination for a max. marks of 80, as in c & d below, which is **scaled down** to 25 or 20 based on the selected pattern of format.
 - A candidate should attend both the parts of summative assessments; else he will be put into 'I' grade.
- c) For each L-based course integrated with T/P, the summative assessment shall be conducted by the Institute for a duration of 150 min. and for a maximum of 80 marks. Contents for summative assessment shall cover the breadth and depth of the complete syllabus that is mentioned in the two modules of a course.

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- d) The question paper for end-semester theory examination consists of two parts as given in Table (2).

Table 2: L-based Summative Assessment Question Paper Pattern.

Part No.	No. of Questions	Marks for each Question	Marks	Choice
A	4	10	40	No
B	2	20	40	No
Total Marks			80	

- e) The questions will be comprehensive covering the entire course syllabus and any single question should not necessarily be limited to any particular unit / module.
- f) These marks are **suitably mapped down** to a score of 40.
- g) Total marks of summative assessment will be for a max. of 40 irrespective of format of evaluation.
- h) The award of 'I' grade is solely based on marks scored in summative assessment out of 40, if he/she does not score a min. 16 out of 40 (40%).

5.4 P-based Courses

The detailed information consisting of experiments, batch formations, experiment schedules, etc., will be displayed / informed to the student in the first week of the semester so that the student comes prepared for the lab sessions. Copies of the manual will be made available to the students along with the schedule. The manual will consist of the list of equipments, detailed procedure to conduct the experiment, format for record writing, outcomes for each experiment and possible set of short questions to help students gain critical understanding. The courses like Cyber security, Research Methodology & IPR will also be treated as P-based courses.

5.4.1 Formative Assessment

During practice sessions, a brief viva-voce is conducted for each student on the experiment he/she is carrying out on that day. Some of the parameters that could be included in the Continuous Practice Assessment (CPA) are given in Table (3). The set of parameters may slightly differ from one laboratory to the other, and will be announced before the commencement of the practice session. These parameters are assessed for each laboratory session.

Table 3: Suggested parameters for Continuous Practice Assessment (CPA).

S. No	Component	Marks
1	Report of about 1 page on proposed experimental layout and background theory before the start of lab session	4
2	Viva and interaction to evaluate understanding of concepts	4
3	Experimentation and data collection	4
4	Analysis of experimental data and interpretation	4
5	Finalized report submitted in the next week	4
Total		20

This assessment is carried out for each practical session and the total marks of all practical sessions will be **suitably mapped down** to a max. of 60.

5.4.2 Summative Assessment

End semester examination for each practical course is conducted jointly by two examiners. The examiners are appointed by Dean, AAA from the panel of examiners suggested by the respective Heads of the Department. In some cases, one of the examiner may be from outside the institution and will be identified as external examiner. The scheme of assessment may vary depending on the nature of laboratory, which shall be shared with student by the

laboratory in-charge. The summative assessment will be conducted for a max. marks of 40. The general scheme of assessment is given in Table (4).

Table 4: Suggested end-semester summative assessment pattern for P-based courses.

Component	Marks		
	Examiner 1	Examiner 2	Total
Objective & Procedure write up including outcomes	4	4	08
Experimentation and data collection	4	4	08
Computation of results	4	4	08
Analysis of results and Interpretation	4	4	08
Viva Voce	0	8	08
Total Marks	16	24	40

5.5 Assessment and Grading of MOOCs based elective

Whenever a candidate opts for a course through MOOCs offered via Swayam platform, he / she has to learn and undergo assessment as per norms set by VFSTR for such MOOCs Courses. Upon the declaration of the result, that the candidate has successfully completed the course, the candidate is said to have earned the credits under credit equivalence and credit transfer.

5.6 Inter Departmental Project

Inter departmental project work is undertaken in the 2nd semester for earning 2 credits by each candidate. It is expected that the inter- departmental Projects result in publication of a technical paper in a peer-reviewed journal. For this purpose, Dean R&D and Heads of Department will identify faculty mentors who will guide the students by conducting workshops on drafting of research article, communication, process of peer-review, publication, etc. The faculty will support the students by all means to get the technical findings published in peer-reviewed journals.

5.6.1 Formative Assessment

The assessment will be carried in two reviews in a systematic way. The detailed assessment guidelines and scheme are to be announced along with the assessment schedule as mentioned in the Table (5).

Table 5: Schedule and parameters followed for formative assessment.

No of Module	Schedule	No of reviews	Points to be considered	Formative assessment marks
Module -1	7th – 8th week	Review -1	<ul style="list-style-type: none"> • Identification of specific area out of broad areas under the supervisor • Identification of outcomes in line with programme objectives. • Feasibility of contributing to the attainment of outcomes • Identification of tools / equipment / surveys / training needs / etc.. 	30
Module – 2	15th– 16th week	Review -2	<ul style="list-style-type: none"> • Presentation of results, analysis and conclusions • Meeting of objectives defined in first review • Preparation of report • Understanding by individual students on the overall project • Submission of technical article 	30





5.6.2 Summative Assessment

Summative assessment will be done jointly by two examiners. The examiners are appointed by Dean, AAA from the panel of examiners suggested by the respective Head of the Departments. In some cases, one of the examiner may be from outside the institution and will be identified as external examiner. The scheme of assessment will be report (15 marks), presentation (10 marks) and demonstration (15 marks) respectively. Points to be considered during the review.

- a) Presentation of results, analysis and conclusions
- b) Meeting of objectives defined in first review
- c) Preparation of report
- d) Understanding by individual students on the overall project
- e) Individual student contribution
- f) Progress of project as per schedule
- g) Submission of technical article/ prototype realization

5.7 Project

Those students who do not opt for the internship, carry out their major project at VFSTR and submit their report which is a mandatory requirement for the award of degree. These projects are usually done individually during third and fourth semesters, under the guidance of a faculty member. Every candidate, in consultation with the guide, should define the project and also the probable procedure of carrying it out and submit the same to a committee consisting of 2 to 3 faculty members appointed by Head of the Department. This is to avoid the repetition and also to come up with a roadmap for completion of the project within the time stipulated. The students are encouraged to select topics related to ongoing research and consultancy projects. The students are expected to carry out and present a survey of literature on the topic, work out a project plan and its implementation through experimentation / modelling / simulation / computation. They are also expected to exhibit system analysis, design, and presentation and evaluation skills.

5.7.1 Formative Assessment

The progress of project is reviewed twice in a semester by the Project Review Committee (PRC) and formative assessment marks are awarded based on these reviews. The Project review committee consists of

- a) Head of Department or his/her nominee – Chairperson
- b) A senior faculty member identified by the HoD – member
- c) Project supervisor – member

Review schedules of PRC are to be announced by the department immediately after the commencement of semester. The review presentations are open to all the students of that section and attendance is compulsory. The first review should be of 15 minutes / student; second review should be around 30 minutes / student. Before every review every student should submit their PPT along with a brief report of not exceeding two pages. It is to be expected by the committee that student communicates / publishes research article based on the project work prior to graduation either in a peer-reviewed journal or top-notch conference. Based on the recommendations of the committee, he / she is expected to continue same research problem in the third and fourth semesters to derive possible solutions. The following aspects may be considered by the committee for assessment Table (6).



**Table 6:** Schedule and suggested parameters to be considered for formative assessment.

Semester	Module	Schedule	Review	Points to be considered	Max. Marks
Semester III	Module -1	7th – 8th Week	First review	<ul style="list-style-type: none"> • Identification of specific area out of broad areas. • Identification of outcomes in line with programme objectives • Feasibility of contributing to the attainment of outcomes 	20
	Module -2	15th – 16th Week	Second review	<ul style="list-style-type: none"> • Identification of tools / equipment / training needs / etc. • Understanding by individual students on the overall aspect of the project • Completion of literature survey • Design of project set up 	40
Semester IV	Module -1	7th – 8th Week	First review	<ul style="list-style-type: none"> • Acquisition / learning of the tool required • Readiness of the layout of the project report • Progress review as per mechanism / schedule identified • Preparation of draft manuscript for publication 	20
	Module -2	15th – 16th Week	Second review	<ul style="list-style-type: none"> • Presentation of results and conclusions • Meeting of objectives defined in first review • Submission of draft report • Understanding by individual students on the overall project • Progress of project as per schedule • Progress of the publication 	40

5.7.2 Summative Assessment

At the end of III & IV semesters, summative assessment of the project will be conducted in two phases.

Phase-I: This is an evaluation for a max of 20 marks. A committee of two members comprising of HoD's nominee and Guide will assess the project work which will involve going through the project report (6 marks), project presentation (7 marks) and demonstration of the project (7 marks).

Phase-II: A final presentation and defense assessment for a max. of 20 marks will be carried out by one-man committee composed of an external expert who is chosen by the Dean AAA from a panel of examiners suggested by the HoD. The format for evaluation will involve going through the project report's quality (6 marks), presentation (6 marks) and interaction and defense (8 marks).

The qualifying marks will be finalized considering the marks scored in both the phases (I & II) of summative assessment.

Publication in a top-notch conference / peer-reviewed journal is mandatory for evaluating the project for 100% weightage.





In case the candidate is placed in 'I' grade, he/she has to appear for both Phase-I and Phase-II assessments, which will be held within the 15 days after declaration of results. In the consecutive assessment also if the candidate fails to secure min. required score, then he / she will be placed in 'R' grade.

5.8 Internship

Internship work is undertaken by a student in an industry, under the joint supervision of industry personnel and an internal faculty member. Sixty percentage of the marks of Internship are allotted through continuous evaluation as formative assessment and the remaining 40% are based on summative assessment.

Table 7: Assessment scheme for Internship reviews.

Semester	Module	Schedule	Review	Formative assessment marks
Semester III	Module -1	7th – 8th Week	First review	20
	Module - 2	15th – 16th Week	Second review	40
Semester IV	Module - 1	7th – 8th Week	First review	20
	Module - 2	15th – 16th Week	Second review	40

- The progress of internship work is reviewed twice in every semester by the “Internship Review- Committee (IRC)” and marks for formative assessment are awarded based on these reviews.
- The IRC consists of Head of Department or his/her nominee (Chairperson), the internal and external (industry) supervisors.
- The IRC may not be the same for all students; however, the same IRC should exist for entire duration of the internship program of any single student.
- The schedule and the scheme of evaluation are to be announced with internship notification. The internship reviews may take place at the place of internship or at the university, as decided by the interning organization or may be conducted in the blended mode.

5.8.1 Formative assessment: Internal reviews at the place of internship

The internal supervisor will interact with the guide allotted at internship offering industry based on the schedule given to conduct the reviews. Scheduled reviews can be conducted by IRC on online mode for discussion/ presentation. The marks shall be distributed for each student in the scheduled reviews as given in Table (7).

- Students should submit a report (not more than two pages) explaining about the progress of their work, mentioning clearly details like the machines or software handled / adopted, type of data collected and his/her understanding and contribution in the programme, and the same has to be presented before the supervisors.
- The candidate should clearly present the completion of stipulated assignments set by the industry supervisor for that period.
- The evaluation will be based on a & b above and also based on regularity and discipline maintained in the internship venue.

Table 8: Suggested scheme of assessment for every review

Component	First review	Second review
Regularity and interaction	5	10
Application of knowledge	3	6
Gaining of new knowledge /skills / literature survey	3	6
Internship progress	5	10
Report	4	8
Total marks	20	40



5.8.2 Summative assessment – Internship

At the end of III and IV semesters, the student shall submit a comprehensive report of internship covering the work done and make a final presentation in two phases as follows:

Phase–I: A committee of two members comprising of internal supervisor and HoD's nominee will assess the overall internship participation by the candidate and his final report through presentation made by the intern. The internship report (6 marks), presentation (7 marks) and overall impression (7 marks) during the internship will be evaluated respectively.

Phase–II: A final presentation and defense assessment for a max. of 20 marks will be carried out by one-man committee composed of an external expert who is chosen by the Dean AAA from a panel of examiners suggested by the HoD. The format for evaluation will involve going through the project report's quality (6 marks), presentation (6 marks) and interaction and defense (8 marks).

The qualifying marks will be finalized considering the marks scored in both the phases (I & II) of summative assessment.

Publication in a top-notch conference / peer-reviewed journal is mandatory for evaluating the Internship for 100% weightage.

In case the candidate is placed in 'I' grade, he / she has to appear for both Phase-I and Phase-II assessments, which will be held within the 15 days after declaration of results. In the consecutive assessment also if the candidate fails to secure min. required score, then he / she will be placed in 'R' grade.

6. SEMESTER-END ASSESSMENT ACTIVITIES

- 6.1 Setting of semester-end summative assessment question papers will be coordinated by the instructor assigned for a particular course. Two sets of question papers will be submitted latest by 12th week of the semester.
- 6.2 There shall be 'Summative Assessment Question Paper Scrutiny Committee' which would be constituted with external experts. Experts are empowered to modify / rephrase the questions to maintain a high standard of the semester-end assessment. The review should be completed by the 14th week of the semester. The review process will be coordinated by a committee of School Dean, HoDs and external experts.
- 6.3 The question wise marks scored in the summative assessment out of a total of 80 will be made available online within two weeks from the last date of examination and would be kept active for 24 hours. Latest by the end of 48 hours from the instant of notification any candidate can submit an appeal online providing question wise claim.
- 6.4 Claims for re-assessment on P-based courses are not allowed.
- 6.5 The appeals will be attended within next three working days. Fees for appeal, as decided from time to time, has to be remitted online along with the appeal.
- 6.6 Final results and grades will be computed as explained in the next section.
- 6.7 Final results and grades shall be announced within four weeks of completion of the last examination of the summative assessment (within two weeks from the last date of appeal). Grades are published on the University website, and also informed to the parents and students through SMS.
- 6.8 Provisional Grade cards will be issued within two weeks after the announcement of grades. Grade card will contain three parts. Part 1: Details of successfully completed courses. Part 2: Details of 'I' grade courses. Part 3: Details of 'R' grade courses.

7 COMPUTATION OF GRADING

- 7.1 Formative assessment decides the list of 'R'- candidates. Therefore, these candidates will not be considered for grading computation. Summative assessments decide the list of 'I' candidates. Therefore, these candidates will not be considered for grading computation.





- 7.2 The candidates who have successfully completed both formative and summative assessments will be considered for computation of relative grading.
- 7.3 Threshold value (**Th**) for relative grading in each course is arrived after studying the marks distribution in that course by a committee constituted by office of Dean AAA. The threshold value is decided by the upper bound marks of the major chunk of the class keeping the top outlier scores away from consideration (the least upper bound). The threshold value will be slightly greater than upper bound marks or may be equal to the upper bound marks.
- 7.4 The total marks (**m**) = marks scored in the formative assessment + marks scored in the summative assessment is transformed into relative grade expressed accurate to two decimal places as follows:

$$\text{Relative grade point (P)} = (m/Th) \times 10 \text{ [and limited to 10]}$$

- 7.5 If students require course wise percentage equivalence, then the calculation will be based on the following

$$\text{Course wise percentage equivalence} = (m/Th) \times 100 \\ \text{[truncated to two-digit integer and limited to 100]}$$

- 7.6 After relative grading, a student is assigned a 'Letter Grade (G)' for each course as per Table (9). The grade and the corresponding letter grade represent the outcomes and assessments of a student's performance in a course.

Table 9: Grading information

Relative Grading Range (P)	Category	Grade (G)
≥ 9.50	Outstanding	O
≥ 8.50 to 9.49	Excellent	S
≥ 7.00 to 8.49	Very good	A
≥ 6.00 to 6.99	Good	B
≥ 5.00 to 5.99	Fair	C
≥ 4.50 to 4.99	Marginal	M
Transitional Grade	Repeat	R
Transitional Grade	Incomplete	I

8. SUPPLEMENTARY EXAMINATIONS

- 8.1 The supplementary examinations shall be conducted once in summer semester. Notifications will be released by the AAA section informing the students about registration procedures, details of fee and timetables. Apart from these examinations the students who have courses with 'I'-grade can also write the supplementary examinations along with regular semester-end examinations of that academic (Odd / Even) semester.
- 8.2 Whenever a candidate clears courses with 'I' grade in a supplementary examination that are conducted during a regular semester, the Threshold value for computing his / her grade will be obtained from the same batch in which he / she had completed his / her formative assessment.
- 8.3 Whenever a candidate clears courses with 'R' / 'I' grade in a summer semester, the Threshold value for computing his / her grade will be carry forwarded from the preceding Odd / Even semester for the respective courses.
- 8.4 Whenever a candidate clears courses with a 'R' grade in a regular semester along with his/her junior batch then for this candidate the Threshold value will be corresponding to his/her junior batch for computing grade.
- 8.5 The results of summative assessment of Project / Internship will be announced only if the candidate successfully earn all the credits in courses registered during the program. If the candidate is with 'R' / 'I' graded courses the results will be kept under '**Announced Later (L)**' status and will be announced only after candidate clears these courses.





9. GRADE POINT AVERAGE

The Academic Performance of a student in every semester is indicated by the Semester Grade Point Average (SGPA) and finally by Cumulative Grade Point Average (CGPA).

9.1 SGPA

The Semester Grade Point Average (SGPA) shall be computed using the formula given below:

$$SGPA = \frac{\sum_{i=1}^n C_i P_i}{\sum_{i=1}^n C_i}$$

Where

n = number of courses a student successfully completed in the semester under consideration

P_i = Grade points secured for the ith course registered in the semester under consideration.

C_i = the number of credits assigned to ith course registered in the semester under consideration.

9.2 CGPA

The Cumulative Grade Point Average (CGPA) shall be computed after successful completion of the programme. The CGPA shall be expressed in different flavors to reflect M.Tech. of 68 credits, and Add-on certification up to 12 credits.

Accordingly, the computations will be as below:

$$CGPA = \frac{\sum_{j=1}^m C_j P_j}{\sum_{j=1}^m C_j}$$

Where

m = total number of courses prescribed for the completion of the programme

P_j = grade points secured for the jth course.

C_j = the number of credits assigned to jth course

and $\sum C_j = 68$

$\sum C_j = 08$ for CGPA calculations in case of M.Tech. with Add-on certification

$\sum C_j = 12$ for CGPA calculations of specialization part in case of M.Tech. with Add-on certification

Percentage equivalence of SGPA & CGPA = (SGPA or CGPA) X10

10. AWARD OF CLASS

The students who have become eligible for award of degree shall be classified based on their CGPA secured, as per the Table (10) given below:

Table 10 : Class/ Division information.

Sl. No.	CGPA	Class / Division
1	8.0 and above	First Class with Distinction
2	6.5 and above but less than 8.0	First Class
3	6.0 and above but less than 6.5	Second Class
4	Less than 6.0	Pass Class

- a) For the purpose of rewarding the accomplishers with ranks and awards, toppers in each branch discipline are identified, based on their academic performance (CGPA) in the following categories:
 - i) Ranking in M.Tech.
 - ii) Ranking in M.Tech. with Add-on certification
- b) In addition, the 'Chairman's gold medal' and other 'Endowment Awards' are awarded to



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the 'outstanding students' based on the overall performance which includes academic, co-curricular and extra-curricular activities, campus placements and competitive examinations. A committee appointed by the Vice-Chancellor will recommend the eligible student for the award, selected from the nominations received from the departments.

- c) In addition, the institution may recognize exceptional performance such as music, dance, sports etc. and display of exceptional bravery from time to time.
- d) Only such candidates who complete 68 credits (+12 credits) in the first 4 successive semesters shall be eligible to receive awards/ ranks.
- e) The candidates availing spill over semesters will not be eligible for the award of merit scholarships.

11. AWARD OF DEGREE

On successful completion of prescribed requirements of the programme, the degree shall be conferred during the convocation of the VFSTR.

For the conferment of degree, the student has to fulfill the following requirements:

- a) a bonafide student and undergone the course work of not less than two academic years and not more than four academic years from the date of joining.
- b) successfully completed all the courses as prescribed in the respective curriculum.
- c) acquired a minimum eligible credits i.e. 68 credits for the award of M.Tech. degree.
- d) obtained no due certificates as prescribed by VFSTR.
- e) no in-disciplinary proceedings pending against him / her.

Consequent upon being convinced, following an enquiry, the Academic council may resolve to withdraw the degree / diploma / any other certification provided by the institute. The aggrieved may however prefer for a review of such decision by the Academic Council, citing cogent reasons for review or go in for an appeal to the, BoM of the institute.

12. Honorable exit with Engineering PG Diploma

In line with NEP-2020, an optional exit is provided for a candidate who has earned a min. of 40 credits and has completed all the requirements up to the end of two semesters.

Engineering PG Diploma will be awarded in respective branches of specialization. In case the candidate fails to earn 40 credits, a suitable certification will be awarded during his / her exit from M.Tech. degree.

Semester-wise transcript and a consolidated transcript will be given to the candidates during their exit from the registered program.

Such a candidate who has exited can seek re-entry to complete M.Tech. by surrendering the Engineering PG Diploma. A committee constituted by Vice-Chancellor will scrutiny all such re-entry requests and recommend the plan of action. However, the max. duration of programme should be limited to four years and further extension beyond the stipulated max. duration of study has to be approved by Academic Council, if the candidate appeals for an extension.

13. Onward Continuation to Ph.D. Program

As per the section 6.2 of R-22 Ph.D. regulations, candidates pursuing M.Tech. at VFSTR, who have completed all the courses prescribed for the first 2 semesters with a minimum of 60% or equivalent CGPA may be considered for onward continuation to Ph.D. program with a provisional admission to Ph.D.

For such candidates, a faculty mentor is allocated after the provisional admission. Mentor could become a Research Supervisor for the Ph.D program after confirmation of Ph.D admission at VFSTR, which is after formally completing M.Tech degree requirements.

Candidate in consultation with the faculty mentor shall identify the broad area of research topic and can utilize the M.Tech Project as a preliminary work before commencing the intensive research work during Ph.D programme. The M.Tech project work under the guidance of faculty mentor should satisfy all the mandates prescribed in the regulations of M.Tech. However, candidate is required to hold a Master's degree in Engineering / Technology with a minimum of 60% or equivalent CGPA before being formally admitted into the Ph.D program





14. Volunteer 'Drop' with Sabbatical Semester option

A candidate may exercise his option to voluntarily exit from M.Tech. programme temporarily for a semester during the M.Tech. programme, by registering for a 'DROP option' in the beginning of the semester after completion of first two semesters. The DROP can be exercised to take up special Internship / Innovation / Exploratory / Entrepreneurship / Advanced research / Start-up and such related activities. Under such circumstances a candidate can normally avail DROP over two successive semesters. Such 'Drop' semester will be identified as Sabbatical semesters.

Such a candidate has to pay the regular semester fee if such a Drop option is utilized during the first 4 semesters of M.Tech., and has to pay a nominal semester maintenance fee during the spillover period, if a candidate has not yet completed the credit requirements.

Upon returning from such a temporary exit, a candidate may continue his M.Tech. studies utilizing the provision of spillover period. A candidate may also submit a claim for Credit equivalence for the activities undertaken during the sabbatical period. The equivalence committee would evaluate and assess the academic equivalence of the work carried out and would recommend the credit equivalence and credit transfer to be granted together with the grades that could be attributed, if applicable. However, the max. duration of programme should be limited to four years and further extension beyond the stipulated max. duration of study has to be approved by Academic Council, if the candidate appeals for an extension.

14.1 Volunteer 'Drop' with Semester Drop option

A candidate may exercise his option to voluntarily exit from M.Tech. programme temporarily for a semester during the M.Tech. programme, by registering for a 'DROP option' in the beginning of the semester to meet the family / personal exigencies. All the norms as mentioned in the section (14) shall be applicable for the candidates utilizing semester drop option.

15. INTERPRETATION OF RULES

- a. The academic rules and regulations should be read as a whole for the purpose of any interpretation.
- b. For the matter(s) NOT covered herein above or for unforeseen circumstances, but arising during the course of the implementation of the above regulations. The Vice-Chancellor shall be authorized to remove the difficulties and decide upon the matters. The same shall be reported in the next meeting of Academic Council for ratification and subsequently informed to BoM.
- c. The Institution may change or amend the academic rules and regulations or curriculum at any time, and the changes or amendments made shall be applicable to all the students with effect from the dates, notified by the Institution.
- d. Procedure and explanation to any section can be floated by the office of Dean AAA as applicable from time to time with due approval by the chairman of Academic Council.



R22 M.Tech.

2 YEARPG
PROGRAMME**R22 - M.Tech. - Course structure****I Year I Semester**

Course Code	Course Title	L	T	P	C
	Professional Core - 1	2	2	2	4
	Professional Core – 2	2	2	2	4
	Professional Core – 3	2	2	2	4
	Department Elective – 1	2	-	2	3
	Department Elective – 2	2	-	2	3
	Cyber security	1	2	-	2
	Employment Orientation Program	-	2	2	2
Total		11	10	12	22
33 Hrs					

I Year II Semester

Course Code	Course Title	L	T	P	C
	Professional Core – 4	2	2	2	4
	Professional Core – 5	2	2	2	4
	Department Elective – 3	2	-	2	3
	Department Elective – 4	2	-	2	3
	Research Methodology & IPR	1	2		2
	Inter Departmental project	-	1	3	2
	Teaching assistantship	-	-	4	2
Total					20
	Add-on certification course -1	3	-	2	4
Total		11	7	17	24
35 Hrs					

II Year I Semester

Course Code	Course Title	L	T	P	C
	Project / Internship	-	2	24	13
	Add-on certification course -2 (MOOCs / Self-Study Course)	4	-	-	4
Grand Total		4	2	24	17

II Year II Semester

Course Code	Course Title	L	T	P	C
	Project / Internship	-	2	24	13
	Add-on certification course -3 (MOOCs/ Self-Study Course)	4	-	-	4
Grand Total		4	2	24	17



Department of Electronics and Communications Engineering

M.Tech. Embedded System

Course Structure R22

I YEAR I SEMESTER							
S.No	Course Code	Course Type	Course Title	L	T	P	C
1.	22ESB101	Professional Core -1	Advanced Micro controllers-I	2	2	2	4
2.	22ESB102	Professional Core -2	Real Time Operating system	2	2	2	4
3.	22ESB103	Professional Core -3	Algorithms	2	2	2	4
4.		Department Elective -1		2	2	-	3
5.		Department Elective -2		2	-	2	3
6.	22CYB101	Cyber Security	Cyber Security	-	2	2	2
7.	22SAB101	EOP	EOP	-	2	2	2
Grand Total				10	12	12	22
				34 Hrs			

I YEAR II SEMESTER							
S.No	Course Code	Course Type	Course Title	L	T	P	C
1.	22ESB104	Professional Core -4	Advanced Micro controllers II	2	2	2	4
2.	22ESB105	Professional Core -5	Data structures and algorithms for embedded programming	2	2	2	4
3.		Department Elective -3		2	2	-	3
4.		Department Elective -4		2	-	2	3
5.	22MSB101	RM & IPR	Research Methodology & IPR	-	2	2	2
6.	22ESB106	Interdepartmental Project	Interdepartmental Project	-	1	3	2
7.	22ESB107	Teaching Activity	Teaching Assistanceship	-	-	4	2
Total				20			
8.		Add-on certification-1		3	-	2	4
Grand Total				12	9	15	24
				35 Hrs			24

II YEAR I SEMESTER						
S.No	Course Code	Course Type	L	T	P	C
1.	22ESB202 / 22ESB201	Project / Internship	0	2	24	13
2.		Add on certification-2 (MOOCS/ Self-study)	4	0	0	4
Grand Total			4	2	24	17
			30 Hrs			

II YEAR II SEMESTER						
S.No	Course Code	Course Type	L	T	P	C
1.	22ESB204 / 22ESB203	Project / Internship	0	2	24	13
2.		Add on certification-3 (MOOCS/ Self-study)	4	0	0	4
Grand Total			4	2	24	17
			30 Hrs			

DEPARTMENT ELECTIVE COURSES						
S.No	Course Code	Course Title	L	T	P	C
1.	22ESB801	Communication Technologies I	2	2	0	3
2.	22ESB802	Communication Technologies II	2	2	0	3
3.	22ESB803	IoT Architecture	2	0	2	3
4.	22ESB804	FPGA based System Design	2	0	2	3
5.	22ESB805	Digital Image Processing	2	2	0	3
6.	22ESB806	Embedded System Security	2	0	2	3
7.	22ESB807	Sensors and Actuators	2	0	2	3

ADD-ON CERTIFICATION COURSES						
S.No	Course Code	Course Title	L	T	P	C
1.		MOOCS/ Self-study	2	2	0	3
2.		MOOCS/ Self-study	2	2	0	3
3.		MOOCS/ Self-study	2	0	2	3

22ESB101 – ADVANCED MICROCONTROLLERS-I

Hours per week:

L	T	P	C
2	2	2	4

MODULE-1

UNIT-1 INTRODUCTION AND ARCHITECTURE OF CORTEX-M PROCESSORS

Introduction to ARM Cortex-M Processors, Introduction to Embedded Software Development, General information about the Cortex-M3 and Cortex-M4 processors, Features of the Cortex-M3 and Cortex-M4 processors.

Architecture introduction, Programmer's model, Behavior of the application program status register (APSR), Memory system, Exceptions and interrupts, System control block, The STM32F4Microcontroller.

UNIT-2 INSTRUCTION SET

Background to the instruction set in ARM_Cortex_-M processors, Comparison of the instruction set in ARM Cortex-M processors, Understanding the assembly language syntax, Use of a suffix in instructions, Unified assembly language (UAL), Instruction set, Cortex-M4-specific instructions, Barrel shifter, Accessing special instructions and special registers in programming.

MODULE-2

UNIT-1 DIGITAL I/O AND TIMING OPERATIONS

Bit Values as Voltage Levels, Digital I/O Setup on the STM32F4 Microcontroller, Clock signals in Embedded systems, Timers, Timer setup.

UNIT-2 CONVERSION BETWEEN ANALOG AND DIGITAL VALUES

Analog and digital values, Analog to digital conversion, ADC setup in STM32F4 Microcontroller, DAC setup in STM32F4 Microcontroller.

PRACTICES:

- Implement any one of the digital filter on ARM
- Implement digital I/O operations in a robot vacuum cleaner
- Implement timing operations in the robot vacuum cleaner
- Measure the frequency of a square wave using Timer unit
- Demonstrate PWM operation using Timer
- Generate Delays using Timer
- Interface two temperature sensors to a ADC
- Generate a sine wave using DAC
- Implement ADC operations in robot vacuum cleaner
- Implement DAC operations in robot vacuum cleaner

TEXT BOOKS:

1. Joseph Yiu, "The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors", Newnes, 3rd Edition, 2013.
2. Cem Ünsalan, Hüseyin Deniz Gürhan, Mehmet Erkin Yücel," Embedded System Design with Arm Cortex-M Microcontrollers", Springer, 2022.

REFERENCES BOOKS:

1. Rob Toulson Tim, Wilmshurst, "Fast and Effective Embedded Systems Design", Newnes, 2nd Edition, 2017.
2. Trevor Martin, "The Designer's Guide to the Cortex-M Processor Family", Newnes, 3rd Edition, 2022.

3. Zachary Lasiuk, Pareena Verma and Jason Andrews, "The Insider's Guide to Arm Cortex-M Development", packet, 1st edition, 2022.
4. Muhammad Tahir and Kashif Javed, "ARM Microprocessor Systems: Cortex-M Architecture, Programming, and Interfacing", CRC press, 1st Edition, 2017.
5. Andrew N. Sloss, "ARM system developer's guide", Elseiver, 2004.

22ESB102 - REAL TIME OPERATING SYSTEMS

Hours per week:

L	T	P	C
2	2	2	4

MODULE-1

UNIT-1

Process Management in Embedded Systems

Multitasking, The Process , Multitasking and Context , Dynamic Process , Process Synchronization, Event-Driven Embedded Systems Using Sleep/Wakeup , Semaphores , Applications of Semaphores , Other Synchronization Mechanisms, High-Level Synchronization Constructs , Process Communication, Uniprocessor (UP) Embedded System Kernel.

UNIT-2

Memory Management in ARM

Process Address Spaces , Memory Management Unit (MMU) in ARM, MMU Registers, Accessing MMU Registers, Virtual Address Translations, Translation of Section References , Translation of Page References.

MODULE-2

UNIT-1

General Purpose Embedded Operating Systems

General Purpose Operating Systems, Embedded General Purpose Operating Systems, Existing GPOS to Embedded Systems, Develop an Embedded GPOS for ARM, Organization of EOS, Memory Management in EOS, Exception and Signal Processing, Signal Processing in EOS, Device Drivers, Process Scheduling in EOS, Timer Service in EOS, File System, Block Device I/O Buffering, I/O Buffer Management Algorithm, User Interface, Demonstration of EOS.

UNIT-2

Embedded Real-Time Operating Systems

Concepts of RTOS, Task Scheduling in RTOS, Priority Inversion, Priority Inversion Prevention, Survey of RTOS, Design Principles of RTOS, Uniprocessor RTOS (UP_RTOS), Multiprocessor RTOS (SMP_RTOS)

TEXT BOOKS:

1. K. C. Wang, "Embedded and Real-Time Operating Systems", Springer, 2017.

REFERENCE BOOKS:

1. Brian Amos, "Hands-On RTOS with Microcontrollers", 1st edition, Packt, 2020.
2. COLIN WALLS, "EMBEDDED RTOS DESIGN Insights and Implementation", Newnes, 2021.

22ESB103 – ALGORITHMS

Hours per week:

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE:

Basics of computers, number systems, C programming language

COURSE DESCRIPTION & OBJECTIVES:

To acquire knowledge on searching, sorting and various computational algorithms.

MODULE-1

UNIT-1:

Role of Algorithms in Computing: Algorithms, Algorithms as a technology

Deriving Functions: Defining relationship between variables formulating relationships

Digital Building Blocks: Combinational and Sequential Logics, Synthesis

Data Structures: Unions, structures, Stacks, queues, linked lists, pointers and objects.

UNIT-2:

Searching Techniques: Linear Search, Binary Search and their applications.

Sorting: Bubble Sort, Selection Sort, Insertion Sort, Quick Sort, Heap sort, Sorting in Linear time.

Multithreaded algorithms: Basics, matrix multiplication, merge sort

MODULE-2

UNIT-1:

Dynamic Programming: Rod cutting, matrix-chain multiplication, elements of dynamic programming, longest common subsequence, optimal binary search trees

Greedy Algorithms: An activity-selection problem, Elements of the greedy strategy, Matroids and greedy methods

UNIT-2:

Elementary Graph Algorithms: Representations of graphs, Breadth-first search, Depth-first search, Topological sort.

Minimum spanning trees: Growing a minimum spanning tree, The algorithms of Kruskal and Prim.

Single-Source Shortest Paths: The Bellman-Ford algorithm, Single-source shortest paths in directed acyclic graphs, Dijkstra's algorithm.

Approximation Algorithms: The vertex-cover problem, traveling-salesman problem, set covering problem, Randomization and linear programming.

TEXT BOOKS:

1. Introduction to Algorithms-Cormen, Leiserson, Rivest, Stein
2. Programming in C- Balaguruswamy

REFERENCE BOOKS:

1. Let us C- Yeshwant P. Kanetkar
2. Graphs, Networks and Algorithms-Dieter Jungnickel

22ESB104 – ADVANCED MICROCONTROLLERS-II

Hours per week:

L	T	P	C
2	2	2	4

MODULE-1

UNIT-1 UART

Working principles, modules in the STM32F4 Microcontroller, Setup in the STM32F4 Microcontroller, Usage in the STM32F4 Microcontroller.

UNIT-2 IIC AND SPI

Serial Peripheral Interface, SPI Working, SPI Modules in the STM32F4 Microcontroller, SPI Setup in the STM32F4 Microcontroller, SPI Usage in the STM32F4 Microcontroller, Inter-integrated Circuit, I2C Working Principles, I2C Modules in the STM32F4 Microcontroller, I2C Setup in the STM32F4 Microcontroller, I2C Usage in the STM32F4 Microcontroller.

MODULE-2

UNIT-1 CAN AND USB

Controller Area Network, CAN Working Principles, CAN Modules in the STM32F4 Microcontroller, CAN Setup in the STM32F4 Microcontroller, CAN Usage in the STM32F4 Microcontroller, Universal Serial Bus, USB Working Principles, USB Modules in the STM32F4 Microcontroller, USB Setup in the STM32F4 Microcontroller, USB Usage in the STM32F4 Microcontroller.

UNIT-2 DISPLAYS

LCD, Touch screen, Hardware Modules in the STM32F4 Microcontroller for LCD and Touch Screen Control, Setting Up the LCD on the STM32F4 Board, Usage of the LCD on the STM32F4 Board, Setting Up the Touch Screen on the LCD of STM32F4 Board, Usage of the Touch Screen on the LCD of STM32F4 Board, Graphical User Interface Formation via TouchGFX.

PRACTICES:

- Interface a XBee module with STM32F4 microcontroller through UART
- Interface a XBee module with STM32F4 microcontroller through SPI
- Demonstrate working of CAN interface
- Demonstrate working of IIC interface
- Implement a stand-alone remote controller via GUI formation and touch screen usage.

TEXT BOOKS:

1. Cem Ünsalan, Hüseyin Deniz Gürhan, Mehmet Erkin Yücel,” Embedded System Design with Arm Cortex-M Microcontrollers”, Springer, 2022.
2. Joseph Yiu, “The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors”, Newnes, 3rd Edition, 2013.

REFERENCES BOOKS:

1. Rob Toulson Tim, Wilmshurst, “Fast and Effective Embedded Systems Design”, Newnes, 2nd Edition, 2017.
2. Trevor Martin, “The Designer’s Guide to the Cortex-M Processor Family”, Newnes, 3rd Edition, 2022.
3. Zachary Lasiuk, Pareena Verma and Jason Andrews,”The Insider's Guide to Arm Cortex-M Development”, packet, 1st edition, 2022.
4. Muhammad Tahir and Kashif Javed, “ARM Microprocessor Systems: Cortex-M Architecture, Programming, and Interfacing”, CRC press, 1st Edition, 2017.

5. Andrew N. Sloss, "ARM system developer's guide", Elseiver, 2004.

**22ESB105 - DATA STRUCTURES AND ALGORITHMS FOR EMBEDDED
PROGRAMMING**

Hours per week:

L	T	P	C
2	2	2	4

MODULE-1

UNIT-1

Overview of Data Structures: Introduction, Abstract Data Types, Lists ADT, Stacks ADT, Queues ADT **Algorithm Analysis:** Mathematical Background, Model, What to Analyse, Running Time Calculations

UNIT-2

Trees: Introduction, Binary trees, The Search Tree ADT-Binary Search Trees, AVL Trees, Splay Trees and B-Trees.

Hashing: Introduction, Hash Tables, Hash Functions and Open Hashing, Close Hashing, Rehashing. Priority Queues (Heaps)

MODULE-2

UNIT-1

Sorting: Introduction, Insertion Sort, A Lower Bound for Simple Sorting Algorithms, Shell Sort, Heap Sort, Merge Sort, Quick Sort, Sorting Large Structures, Bucket Sort

Graph Theory: Introduction, Topological Sort, Shortest Path Algorithm, Network Flow Problems, Minimum Spanning Tree, Applications of Depth-First Search, Introduction to NP-Completeness

UNIT-2

Algorithm Design Techniques: Greedy Algorithms, Divide and Conquer, Dynamic Programming, Randomized Algorithms, Backtracking Algorithms

TEXT BOOKS:

1. Mark Allen Weiss, —Data Structures and Algorithm Analysis in C, Pearson Education, 1997.
2. Kruse R.L., Data Structure and Program Design, PHI
3. Data structures and Algorithms in C++, Michael T.Goodrich, R.Tamassia and Mount, Wiley student edition, John Wiley and Sons.

REFERENCE BOOKS:

1. Rivest, Cormen, Introduction to Algorithms, MIT Press
2. Ellis Horowitz, Sartaj Sahni, Fundamentals of Data Structures
3. Aaron M. Tenenbaum, Y. Langsam, Moshe J. Augenstein, Data Structures Using C

22ESB801 – COMMUNICATION TECHNOLOGIES – 1

Hours per week:

L	T	P	C
2	2	2	4

MODULE-1

UNIT-1

Introduction to Communication and Networking : Communications, Signal Types and its characteristics (Analog/Digital), Data Transmission Types (Serial/Parallel), Communication Techniques (Asynchronous, Synchronous), Data Transmission Modes (Simplex, Half/Full Duplex), Network Topologies (Star, Ring, Mesh, Point to Point, Tree, Bus, Daisy chain, Multi drop) and its applications, Modulation need and types.

UNIT-2

Wired Communication Protocols and standards: Ethernet (Types, Socket, MAC, IP, ARP, ICMP, TCP, UDP, DHCP), CAN, Modbus(RTU, ASCII), UART (RS485, RS232), OFC and Advantages, Disadvantages and its applications, Introduction to Dial up Modems, Leased line modems.

MODULE-2

UNIT-1

Wireless Communication Protocols and Standards: Zigbee, Bluetooth, Wi-Fi, GPRS, GSM, NFC, IR, LoRa, NB-IoT, Satellite Communication. Advantages, Disadvantages and its applications.

IoT Protocols & procedures: MQTT, COAP, STOMP, AMQP, Addressing, configuration & re-configuration, fault detection, Recovery

UNIT-2

Network Types: Introduction to LAN, WAN, PAN, Internet and Intranet, sensor networks (wired/wireless) and its applications, Introduction to NAT, PAT, DNS, Network Routing algorithms, Introduction to Switch, Hub, Bridges and its working, Network Security and Introduction to Firewall and its applications.

TEXT BOOKS:

1. Introduction to data communication and networking by Wayne Tomasi
2. Introduction to data communication and networking by Behrouz Forouzan
3. Basics of data communications by William Stallings
4. Basics of computer networking by Thomas Robertazzi
5. Wireless Networking Absolute Beginner's Guide by Michael Miller:
6. Designing and Deploying 802.11n Wireless Networks by Jim Geier
7. CAN System Engineering from Theory to Practical Applications
8. Communication (NFC) From Theory to Practice by Vedat Coskun, Kerem Ok

22ESB802 – COMMUNICATION TECHNOLOGIES – II

Hours per week:

L	T	P	C
2	2	2	4

MODULE-1

UNIT-1

Transmission formats – Baseband vs Broadband, LAN topologies, Collision vs broadcast domains, Connectivity devices, Medium access control and Logical link control sublayers, Channel access problem, MAC addressing, Ethernet - evolution of Ethernet, Variants of Ethernet.

UNIT-2

Internetworking : TCP/IP Protocol suite, Comparison with ISO suite, IP address notation, IP address classes, Address masking, Introduction to subnetting, Subnet masking for Class A, B, and C, Supernetting, Classless IP addressing, Classless inter domain routing , Address resolution protocol, Hardware addresses vs IP addresses, IP datagram, Different fields of IP header

MODULE-2

UNIT-1

IPv6 and Routing: Internet protocol version6, Advantages of IPv6, IPv6 Addressing format, IPv6 header, Routing in Internets, Static vs Dynamic routing, Routing Tables, Distance Vector Routing, Link State Routing, Hierarchical routing, Broadcast Routing, Multicast Routing

UNIT-2

Transport and Application Layers: Transport layer protocols, Introduction to transport layer, Port address, User datagram protocol- UDP, Transmission control protocol-TCP, Header of TCP, Various fields of TCP header, TCP connection establishment and termination, TCP error control and Flow control, Domain name system-DNS, Dynamic host configuration protocol-DHCP

TEXT BOOKS:

1. Wayne Tomasi, “Introduction to Data Communication and Networking”, 1/e, Pearson Education 2000
2. A S Tanenbaum, “Computer Networks”, 5th Edition, PHI 2001

REFERENCE BOOKS:

1. James .F. Kurose & W. Rouse, “Computer Networking: A Topdown Approach Featuring”, 3/e, Pearson Education. 2001.
2. Forouzan, ”Data Communications and Networking”, 4th Edition, McGraw Hill 2001.
3. William Stallings, “Data and Computer Communication

22ESB803 - IoT Architecture

Hours per Week:

PREREQUISITE KNOWLEDGE: Introduction to IoT

L	T	P	C
2	2	2	4

COURSE DESCRIPTION AND OBJECTIVES:

This course introduces the Architecture of IoT, basic concepts of IoT architectures and IoT Levels. The Course emphasizes the constraints, requirements, and architectures of hardware and software components for IoT systems. By the end of the course, a student will be able to: (1) Develop IoT solutions based on popular hardware/software platforms to address real-life problems (2) Evaluate the cost, power, and performance trade-offs associated with IoT solutions

MODULE-1

UNIT-1: IoT Overview

[6L+LT+6P=18 Hours]

Introduction to Internet of Things (IoT) - Sense, Communicate, Analyze and ACT, IOT Reference architecture - Sensors, Devices, Controllers, Connectivity, Data processing, Identity and Access, Data management and Analytics, Applications, Data privacy and security, standardization and regulatory limitations. Technology and business drivers, Trends and implications

UNIT-2

[10L+10T+10P=30 Hours]

Sense: Fundamentals of Data Acquisition and digitilization, Analog and digital data acquisition, Sampling, Time avergaing, Static and dynamic characteristics, placement of sensors, Calibration and types of calibrations.

Communication: Fundamentals of communication, Signal Types and its characteristics, Data Transmission Types, Communication Techniques, Data Transmission Modes, Network Topologies and its applications, Communication packets - Header, Footer, Record Length, Integrity check (Checksum, CRC)

PRACTICES:

- Implementation of home automation system using relay module.
- Implementation of traffic signal control using 6LoWPAN.
- Implementation of railway gate control by stepper motors.
- Direction and speed control of DC Motor.
- Familiarization with Arduino/Raspberry pi .
- To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn on led for 1sec after every 2 seconds.
- Write a program on Arduino/Raspberry Pi to publish temperature data to the MQTT broker.
- Write a program on Arduino/Raspberry Pi to subscribe to the MQTT broker for temperature data and print it.

MODULE-2

UNIT-1: IoT communication technologies and Protocols

[8L+8T+8P=24 Hours]

Internet and Web layering, Introduction to wired and wireless communicaton technologies for IoT, Edge connectivity and IoT protocols - MQTT, MQTT-SN, Constrained Application Protocol (CoAP), STOMP, AMQP, Comparison of protocols, Wireless sensor networks

UNIT-2: IoT Platform and Applications

[8L+8T+8P=24 Hours]

Thingworx IoT Platform - Architecture overview, Connecting various sources, Modeling the System, Building Analytical Logics, Notifications and Interactions. Case Studies: Air Quality Monitoring, Smart Farming, Smart Parking and Smart Home

PRACTICES:

- Identify the industrial Sensors
- Interfacing raspberry pi with Boilers
- Implementation of scrolling belt using raspberry pi.
- implementation of the network using raspberry pi.
- To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to the smartphone using Bluetooth.
- To interface node MCU with Arduino/Raspberry Pi and write a program to send sensor data to the smartphone using Blynk Application/Cloud.

SKILLS:

- Analyze the specifications and how well different components work together for IoT Boards.
- Analyze the different Sensor working principles.
- Design a Home automation System.
- Identify the types of IoT application protocols and their uses.
- To enable the students to take up the real-time industry as well as interdisciplinary projects.

ACTIVITIES:

- Model the architectural components of IoT.
- Implementation of the Home Security System, Industrial air pollution system etc...
- Identify the Performance of available protocols.
- IoT implementation to make smart factories.
- IoT Processing & Process Control.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Build the IoT Design with sensors and actuators and analyse the levels of Arduino programming language.	Apply	1	1, 2, 12
2	Make use of sensors for collection data from the physical medium	Apply	1	1, 2, 5, 12
3	Apply the physical layer issues, analyse Medium Access Control Protocols/IoT Protocols	Apply	1	1, 2, 3, 5, 12
4	Categorize various topologies and Data management tools	Analyze	2	1, 2, 12
5	Comprehend network and transport layer characteristics and protocols and implement conventional protocols	Analyze	2	1, 2

TEXT BOOKS:

1. Giacomo Veneri; Antonio Capasso, “Hands-on Industrial Internet of Things : create a powerful Industrial IoT infrastructure using Industry 4.0”, ,Packt Publishing, 2018
2. Vijay Madiseti, ArshdeepBahga,” Internet of Things A Hands-On- Approach”,2014

REFERENCE BOOKS:

1. Bassi, Alessandro, et al, “Enabling things to talk”, Springer-Verlag Berlin An, 2016.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017
3. Hersent, Olivier, David Boswarthick, and Omar Elloumi. The internet of things: Key applications and protocols. John Wiley & Sons, 2011.
4. Buyya, Rajkumar, and Amir Vahid Dastjerdi, eds. Internet of Things: Principles and paradigms. Elsevier, 2016
5. Alasdair Gilchrist,“Industry 4.0: The Industrial Internet of Things” by, ISBN: 978-1-4842-2046-7, APRESS, 2016.
6. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to ConnectingEverything”, 1 st Edition, Apress Publications, 2013.

22ESB804 - FPGA BASED SYSTEM DESIGN

Hours per Week:

L	T	P	C
2	2	2	4

MODULE-1

UNIT-1

VERILOG HDL CODING STYLES: Lexical Conventions - Ports and Modules – Operators - Gate Level Modeling - System Tasks & Compiler Directives - Test Bench - Data Flow Modeling - Behavioral level Modeling - Tasks & Functions.

UNIT-2

OVERVIEW OF FPGA ARCHITECTURES AND TECHNOLOGIES: The role of FPGA in digital design, FPGA types, FPGA Vs Custom Vlsi, FPGA Architectures, SRAM based FPGAs, Antifuse based FPGAs, EPROM based FPGAs, Chip I/O, Circuit design of FPGA Fabrics: Logic elements & interconnects

MODULE-2

UNIT-1

VERILOG MODELLING OF COMBINATIONAL AND SEQUENTIAL CIRCUITS: Behavioral, Data Flow and Structural Realization – Adders – Multipliers- Comparators - Flip Flops - Realization of Shift Register - Realization of a Counter- Synchronous and Asynchronous FIFO – Single port and Dual port RAM – Pseudo Random LFSR – Cyclic Redundancy Check

UNIT-2

SYNCHRONOUS SEQUENTIAL CIRCUIT: State diagram, state table, state assignment- choice of flipflops, Timing diagram, One hot encoding, Mealy and Moore state machines, Design of serial adder using Mealy and Moore state machines - State minimization, Sequence detection, Design examples: Sequence detector, Serial adder, Vending machine using One Hot Controller

REFERENCE TEXTBOOKS:

1. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis” Prentice Hall, Second Edition, 2003.
2. Stephen Brown & Zvonko Vranesic, “Digital Logic Design with Verilog HDL” TATA McGraw Hill Ltd. 2nd Edition 2007.
3. Wayne Wolf, “FPGA Based System Design”, Prentices Hall Modern Semiconductor Design Series.

22ESB805 – DIGITAL IMAGE PROCESSING

Hours per Week:

L	T	P	C
2	2	2	4

MODULE-1

UNIT-I

Digital image fundamentals Introduction: Digital Image- Steps of Digital Image Processing Systems-Elements of Visual Perception - Connectivity and Relations between Pixels. Simple Operations- Arithmetic, Logical, Geometric Operations. Mathematical Preliminaries - 2D Linear Space Invariant Systems - 2D Convolution - Correlation 2D Random Sequence - 2D Spectrum

UNIT-2

Image Transforms: 2D Orthogonal and Unitary Transforms-Properties and Examples. 2D DFT/FFT – DCT - Hadamard Transform - Haar Transform - Slant Transform - KL Transform - Properties and Examples.

Image Enhancement: Histogram Equalization Technique- Point Processing Spatial Filtering- In Space And Frequency - Nonlinear Filtering-Use Of Different Masks

MODULE-2

UNIT-I

Image restoration and construction Image Restoration: Image Observation And Degradation Model, Circulant And Block Circulant Matrices and Its Application In Degradation Model - Algebraic Approach to Restoration- Inverse By Wiener Filtering - Generalized Inverse-SVD And Interactive Methods - Blind Deconvolution Image Reconstruction From Projections.

UNIT-2

Image compression & segmentation Image Compression: Redundancy And Compression Models -Loss Less And Lossy. Loss Less- Variable-Length, Huffman, Arithmetic Coding - Bit-Plane Coding, Loss Less Predictive Coding, Lossy Transform (DCT) Based Coding, JPEG Standard - Sub Band Coding.

Image Segmentation: Edge Detection - Line Detection - Curve Detection - Edge Linking And Boundary Extraction, Boundary Representation, Region Representation And Segmentation, Morphology-Dilation, Erosion, Opening And Closing. Hit And Miss Algorithms Feature Analysis

TEXT BOOKS:

1. Digital Image Processing, Gonzalez.R.C & Woods. R.E., 3/e, Pearson Education, 2008.
2. Digital Image Processing, Kenneth R Castleman, PearsonEducation,1995.
3. Digital Image Processing, S. Jayaraman, S. Esakkirajan, T. Veerakumar, McGraw Hill Education,2009. Pvt Ltd,NewDelhi
4. Fundamentals of Digital image Processing, Anil Jain.K, Prentice Hall of India,1989. Image Processing, Sid Ahmed, McGraw Hill, New York,1999.

22ESB806 - EMBEDDED SYSTEM SECURITY

MODULE-1

UNIT-1

Introduction: Introduction, Services, Attacks, Security model, OSI security architecture and mechanisms, Internet standards and RFC, Buffering.

UNIT-2

Encryption algorithms: Principles, Conventional algorithms, Key distribution, AES, Diffie Hellman, N-parity Deffie Hellman, Elliptic curve and Elliptic curve cryptography, X.509 directory, Authentication services, Hash functions secure hash

MODULE-2

UNIT-1

IP security: IP security overview, Architecture, IPV6 authentication header, Encapsulation Security payload, ESP, Web security requirements.

UNIT-2

Public Key Infrastructure: Digital Certificates, Private Key Management, The PKIX Model, PublicKey Cryptography Standards, XML, PKI and Security. **Internet Security Protocols:** Basic Concepts, Secure Socket Layer, SHTTP, Time Stamping Protocol, Secure Electronic Transaction, SSL versus SET, 3- D Secure Protocol, Electronic Money, E-mail Security, Wireless Application Protocol (WAP) Security, Security in GSM

TEXT BOOKS:

1. Cryptography and Network Security – by Atul Kahate –TMH.
2. Data Communications and Networking- by Behourz A Forouzan
3. Cryptography and Network security,4thed.,Pearson Education, 2010 - William Stallings.
4. Network Security Essentials Applications and Standards, 2nd ed.,Pearson Education,2009 - William Stallings

REFERENCE BOOKS:

1. James .F. Kurouse &W. Rouse, “Computer Networking: A Topdown.Approach Featuring”,3/e, PearsonEducation.
2. Forouzan,”Data Communications and Networking”, 4th Edition,McGraw Hill
3. William Stallings, “Data and Computer Communication”, Eighth Edition, Pearson Education, 2000

22ESB807 - SENSORS AND ACTUATORS

OBJECTIVE:

To make student to acquire the knowledge on types of sensors/transducers, working principles, selection procedure, applications of sensing systems

COURSE OBJECTIVES (COs):

The student will be able to:

- Understand measuring parameters, measuring systems, effects of environment, characteristics, and parameters to be considered for designing an instrument.
- Understand different types of sensors/transducers, working principles, selection procedure, applications of sensing systems.
- Understand Challenges and applications of sensors and sensor networks.
- Select a sensor/sensing system for a requirement.
- Test, install and collect the data from a group of sensors.
- Derive sensor-based solution for different applications.

MODULE-1

UNIT-1

Introduction to Measurement: Measurement units, applications, elements, choosing appropriate measuring instruments. Instrument Types and Performance Characteristics: Review of instrument types, Static characteristics, dynamic characteristics

UNIT-2

Error during measurement process: Sources of systematic error, reduction and quantification of systematic errors, random errors, aggregation of measurement system errors. Calibration: Calibration of measuring instruments, Primary calibration, secondary calibration, and field calibration. Calibration methods for different parameters (temperature, pressure, humidity, flow...etc.). Automatic Calibration mechanisms

MODULE-2

UNIT-1

Temperature, Humidity / Moisture Sensors: Thermo-resistive, Resistance Temperature Detectors, Silicon Resistive, Thermistors, Semiconductor, Optical, Acoustic, Piezoelectric

Humidity and Moisture Sensors: Capacitive, Electrical Conductivity, Thermal Conductivity, Optical Hygrometer, Time Domain Reflectometer. Ex: PT100, PT1000 interfacing, SHT75 Sensor. Case Studies: Indoor and Outdoor environment monitoring

Occupancy and Motion Detectors: Ultrasonic, Microwave Motion, Capacitive Occupancy, Visible and Near-Infrared Light, Far-Infrared Motion, PIR Motion, Position, Displacement, and Level Sensors: Potentiometric, Gravitational, Capacitive, Inductive and Magnetic, Optical, Ultrasonic, Radar. Case Studies: Building Controls

UNIT-2

Velocity and Acceleration Sensors: Capacitive Accelerometers, Piezoresistive Accelerometers, Piezoelectric Accelerometers, Thermal Accelerometers, Heated-Plate Accelerometer, Heated-Gas Accelerometer, Gyroscopes, Piezoelectric Cables.

Pressure and Force Sensors: Mercury Pressure, Bellows, Membranes, and Thin Plates, Piezoresistive, Capacitive, Optoelectronic, Vacuum, Strain Gauges, Tactile, Piezoelectric Force

Case studies in manufacturing industries, robotics, vibration sensing.

TEXTBOOKS:

1. Measurement and Instrumentation Principles - Morris, Alan S
2. An Introduction to Error Analysis by John R. Taylor
3. Sensor Technology Handbook, John S. Wilson
4. Mechanical Measurements – Beckwith, Marangoni, Lienhard.
5. G.C.M. Meijer, Smart Sensor Systems, John Wiley and Sons

REFERENCE BOOKS:

1. Mechanical Measurements – Beckwith, Marangoni, Lienhard
2. Measurement of Systems - Application and design - Earnest O. Doebelin
3. Electronic Instrumentation and Measurement Technique - Albert D Helfrick
4. E.O. Doebelin, D.N. Manik, Measurement systems, Tata McGraw Hill
5. J.P.Bentley, Principles of Measurement systems, Pearson Education Ltd