SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Technology
An Autonomous Institute Permanently Affiliated to the University of Mumbai

Item No. 4.B.3
A.C. Date: 03/07/2024

Autonomy Syllabus Scheme III (2023-24)

(As per NEP 2020 Guidelines)

for

Four Year Multidisciplinary

Bachelors of Technology (B. Tech.) Program

in

Electronics and Telecommunication Engineering with

Multiple Entry and Multiple Exit Options

Levels 4.5 - 6

(Second Year Effective from A.Y. 2024-25)

From the Principal's Desk:

To address the changing demands of the digital era, it is required to create a future-ready workforce that can navigate the complexities of an interconnected world, drive innovation, and contribute to the nation's growth. The **National Educational Policy 2020 (NEP 2020)** framed by the Government of India recommends a holistic, inclusive, and flexible approach to ensure equitable access to quality education across all levels, promote multidisciplinary research, and impart skill-based education with integration of technology. As per guidelines by the Department of Higher and Technical Education, Government of Maharashtra, the salient features of NEP 2020 aligned curriculum should include:

- Major (Core) Mandatory and Elective Courses
- Open Elective Courses
- Vocational and Skill Enhancement Courses
- Ability Enhancement Courses, Indian Knowledge System, and Value Education Courses
- Co-curricular Courses and Field Projects / Community Engagement Projects / Internship
- Multidisciplinary Minor Courses
- Option for Bachelor's Degree with Honours (based on Additional Credits)
- Option for Bachelor's Degree – Honours with Research (based on Additional Credits)
- Option for Bachelor's Degree with Double Minors (based on Additional Credits)
- Multiple Entry and Multiple Exit Options

Being an **autonomous institute** since the Academic Year 2021-22, **K. J. Somaiya Institute of Technology (KJSIT)**, has well-adapted newer approaches to reach higher levels of excellence in engineering education. Ahead of its time, the academic reforms at KJSIT have already addressed majority of these NEP 2020 aspects through its existing **Syllabus Scheme I, II, and II B** implemented under the academic autonomy. For a complete alignment with NEP 2020, the **KJSIT Autonomy Syllabus Scheme III** is introduced, to be effective from Academic Year 2023-24 across all the branches, progressively from First Year Engineering.

Specifically, the existing curriculum already comprise state-of-the-art **Major (Core) courses** in theory and practical. With an ideology that the root of innovation is 'interest', the curriculum offers wide range of Elective courses — grouped into **Major-related Electives** and **Inter-disciplinary / Open Electives**. At par with international engineering education, it follows a learner-centric approach as well as promotes MOOCs, where the students can choose to study courses concerning areas of their interests, and the same is continued in Scheme III.

Further, under the theme of "Learning by Doing", the existing curriculum includes Skill-Based Learning (SBL), Activity-Based Learning (ABL), and Technology-Based Learning (TBL) as eXposure (SAT) courses — that assure X factor in all the students of the institute. The SAT courses are practiced across the first three years of engineering, focusing on responsibilities towards society, problem-solving abilities, communication skills, ethics, leadership and teamwork, motivation for life-long learning, skills on emerging areas of technology, skills on different languages, etc. In the Syllabus Scheme III, these SAT courses are now aligned and offered as **Vocational Skill - SAT (VS - SAT) courses**, **Skill Enhancement - SAT (SE - SAT) courses**, **Ability Enhancement - SAT (AE - SAT) courses**, and **Value Education - SAT (VE - SAT) courses**.

Further, **Indian Knowledge System - SAT (IKS - SAT) course** is newly introduced in Scheme III that emphasizes on drawing insights from ancient wisdom to address modern challenges. Also, as an extension to the induction program for the First Year students, the introduced **Co-curricular - SAT (CC - SAT) course** aims to induct incumbents with the institutional practices, culture, and values, as well as encourage participation in co-curricular activities.

The component of **Project-Based Learning (PBL)** included in the Syllabus Scheme II is carried forward to Scheme III, wherein the students develop **Community Engagement / Field Projects** in Second, Third, and Last Year as Mini, Minor, and Major Projects respectively. Scheme III also retains the **Internship** component, offered with credits, to equip graduates with the industry trends, practices, and skills required at national and global level.

The duality of PBL and Internship enables student involvement in research, innovation, and entrepreneurship, which are the fulcrums of higher education.

As a new introduction in line with NEP 2020, the Syllabus Scheme III incorporates mandatory **Multidisciplinary Minor courses** in Innovation and Entrepreneurship, Biotechnology, IoT and Cloud Computing, Geographical Information System, Very Large Scale Integration (VLSI) and Artificial Intelligence. These courses promote interdisciplinary thinking and broaden the career prospects, enabling students to develop solutions to real-world problems by combining expertise from multiple domains.

Aligned with NEP 2020, the Scheme III retains the initiative taken through Scheme II / II B of offering **Honours courses** for students who are desirous of pursuing focused interest in 06 emerging areas of technology recognized by AICTE: Internet of Things, Artificial Intelligence & Machine Learning, Cyber Security, Virtual and Augmented Reality, Data Science, and Blockchain. These Honours courses correspond to high-end industry standards and offer multi-fold opportunities of specialization.

As per NEP 2020, the above curricular aspects of Four Years UG Engineering Programme shall be offered with **Multiple Entry and Multiple Exit options**, leading to the conferment of:

- **One Year UG Certificate in Technology:** Awarded after completing First Year of Engineering and acquiring additional 08 credits immediately after First Year.
- **Two Years UG Diploma in Technology:** Awarded after completing Second Year of Engineering and acquiring additional 08 credits immediately after Second Year.
- **Three Years Bachelor's Degree in Vocation (B.Voc.):** Awarded after completing Third Year of Engineering and acquiring additional 08 credits immediately after Third Year.
- **Four Years Bachelor's Degree in Technology (B.Tech.) with Multidisciplinary Minor:** Awarded after completing Fourth Year of Engineering.
- **Four Years Bachelor's Degree in Technology (B.Tech.) Honors with Multidisciplinary Minor:** Awarded after completing Fourth Year of Engineering and acquiring additional 18 credits through Honours courses in respective major discipline over Third & Fourth Year of Engineering.
- **Four Years Bachelor's Degree in Technology (B.Tech.) Honors with Research and Multidisciplinary Minor:** Awarded after completing Fourth Year of Engineering and acquiring additional 18 credits through a research project in respective major discipline during Fourth Year of Engineering.
- **Four Years Bachelor's Degree in Technology (B.Tech.) with Double Minors (Multidisciplinary & Specialization):** Awarded after completing Fourth Year of Engineering and acquiring additional 18 credits through additional courses in another Engg. / Tech. discipline during Second to Fourth Year of Engineering.

Through the implementation of Autonomy Syllabus Scheme III (as per NEP 2020 Guidelines), strategic planning, and joint efforts of all stakeholders, KJSIT is endeavouring to enhance the quality of engineering education and set a benchmark for all the autonomous institutes nationwide.

Dr. Vivek Sunnapwar
Principal and Chairman - Academic Council

Preface by Chairperson – Board of Studies (BoS):

In today's world, lot of technological developments are taking place in the field of Electronics & Telecommunication Engineering in order to meet the current requirements. Hence, there is always a requirement for continuous enrichment of course content in the field of education on regular basis to maintain a good quality of education by the regular revision of curriculum. This will help our students with the upgraded knowledge, help in achieving better employability, opportunities to work with start -ups, chances for good internships at premier organizations/industries and other avenues of higher studies.

The revised curriculum of Scheme-III (Electronics and Telecommunication Engineering) under the autonomy has focussed on all these above mentioned factors and aims to provide strong foundation along with required analytical concepts in the field of electronics & telecommunication. The curriculum is designed keeping in mind the guidelines of NEP-2020. Some of the salient features of the syllabus are as mentioned below.

1. The curriculum is designed with a total of number of 174 credits along with the inclusion of Skill, and Technology and Project based learning.

2. The skill based courses are introduced in the second and third year in which students are exposed to hard/ soft skills. Students are also introduced with the community engagement projects in the second year in current technologies.

3. Third year students are introduced with technology based learning along with skill based courses. The community engagement projects are introduced to the third year students in the specialized core fields

4. Students are introduced to National/Foreign Languages in the second year to make them proficient at job locations as per the requirement.

5. The curriculum is designed to incorporate the electives in (department and institute level) covering the thrust areas that will provide more focussed approach for the students in problem solving and also to be at par with the current industry requirements.

6. The contents of the curriculum is designed taking into consideration the IT domain developments into account and at the same time keeping the focus on core specialization of the program intact

7. The internships are made mandatory and credit based for all the students in semester VIII. The students are provided with the flexibility to carry out internship for entire semester. That helps them to acquaint with the industry work culture

As Chairman BOS, I take this opportunity to thank all the internal and external BOS members, subject experts, industry representatives, alumni, and various other stakeholders for their sincere efforts and valuable inputs in the preparation of course contents, in reviewing the contents and critically analysing the contents.

Dr. Jayashree V. Khanapuri
Head and Chairperson,
Electronics and Telecommunication Engineering Department, KJSIT

Board of Studies (BoS) in Electronics and Telecommunication Engineering – K. J. Somaiya Institute of Technology (KJSIT):

1. **Dr. Jayashree Khanapuri**
   Professor and Head – Department of Electronics and Telecommunication Engineering,
   Chairperson – BoS in Electronics and Telecommunication Engineering, KJSIT
2. **Dr. Namrata Ansari**
   Professor – Department of Electronics and Telecommunication Engineering and Dean – Academics, KJSIT
3. **Ms. Vricha Chavan**
   Assistant Professor – Department of Electronics and Telecommunication Engineering, KJSIT
4. **Dr. Sandhya Kadam**
   Assistant Professor – Department of Electronics and Telecommunication Engineering, KJSIT
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7. **Dr. Kiran Rathod**
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    Assistant Professor – Department of Electronics and Telecommunication Engineering, KJSIT
12. **Ms. Rupali Satpute**
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13. **Mr. Sunil Patil**
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14. **Mr. Harshawardhan Ahire**
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15. **Ms. Pranali Hatode**
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16. **Mr. Amit Kukreja**
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18. **Ms. Sandhya Deshpande**
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19. **Dr. Priya Hankare**
    Assistant Professor – Department of Electronics and Telecommunication Engineering, KJSIT
20. **Ms. Swati Shinde**
    Assistant Professor – Department of Electronics and Telecommunication Engineering, KJSIT
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22. **Dr. Amit Deshmukh**
    Head, Department of Electronics and Telecommunication Engineering,
    D J Sanghvi College of Engineering, Mumbai
23. **Dr. Virendra Shete**
    Professor, MIT – School of Engineering, Pune
24. **Dr. Vivek Agarwal**
    Professor, Department of Electrical Engineering, IIT Bombay

Nomenclature and Alignment of Verticals and Components

Verticals as per NEP 2020 Guidelines	Components Aligning with KJSIT Autonomy Syllabus Scheme I / II / II B	Nomenclature for KJSIT Autonomy Syllabus Scheme III Aligned with NEP 2020 Guidelines
Basic and Engineering Science Courses	Basic Science (BS) Course	Basic Science (BS) Courses
	Engineering Science (ES) Course	Engineering Science (ES) Courses
Major Courses	Professional Core (PC) Courses	Major / Professional Core (PC) Courses
	Professional Elective - Department-level (PE-DLC) Courses	Major / Professional Elective - Department-level (PE-DLC) Courses
Generic / Open Elective Courses	Open Elective - Institute-level (OE-ILC) Courses	Open Elective - Institute-level (OE-ILC) Courses
Multidisciplinary Minor Courses	-	Multidisciplinary Minor (MM) Courses
Vocational Skill Courses	Workshop I; Workshop II; SAT Courses – TBL	Vocational Skill - SAT (VS-SAT) Courses
Skill Enhancement Courses	SAT Courses – SBL (Program Specific)	Skill Enhancement - SAT (SE-SAT) Courses
Ability Enhancement Courses	Professional Communication Skills; SAT Course – SBL (Foreign and/or Indian Modern Languages)	Ability Enhancement - SAT (AE - SAT) Courses
Indian Knowledge System Courses	-	Indian Knowledge System - SAT (IKS - SAT) Courses
Value Education Courses	SAT Course – ABL (National, Global, Societal and Environmental Aspects); Business Communication & Ethics	Value Education - SAT (VE - SAT) Courses
Field Projects / Community Engagement Projects	PBL – Mini, Minor, Major	Community Engagement – Project-Based Learning (PBL)
Internship / Apprenticeship	Internship	Internship (INT)
Co-curricular Courses	Student Induction Program	Co-curricular - SAT (CC - SAT) Courses

Other Abbreviations:

- SAT – Skill/Activity/Technology-Based Learning (Exposure Courses)
- TH – Theory
- P – Practical
- TUT – Tutorial
- T1 – Test 1
- T2 – Test 2
- CA – Continuous Assessment Test (T = T1 + T2)
- ESE – End Semester Exam
- TW – Term Work
- O – Oral Exam
- P – Practical Exam
- P&O – Practical & Oral Exam

Programs Offered with Multiple Entry Multiple Exit Options

Level 4.5: UG Certificate in Technology

Major Discipline:	Electronics and Telecommunication Engineering
Years of Study:	01 Year
Semesters:	1 and 2
Credits:	42
Additional Requirements:	08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major during Summer Vacation after 1st Year

Level 5: UG Diploma in Technology

Major Discipline:	Electronics and Telecommunication Engineering
Years of Study:	02 Years
Semesters:	1, 2, 3, 4
Credits:	85
Additional Requirements:	08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major during Summer Vacation after 2nd Year

Level 5.5: Bachelor's Degree in Vocation (B. Voc.)

Major Discipline:	Electronics and Telecommunication Engineering
Years of Study:	03 Years
Semesters:	1, 2, 3, 4, 5, 6
Credits:	130
Additional Requirements:	08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major during Summer Vacation after 3rd Year

Level 6: B.Tech. in Technology with Multidisciplinary Minor

Major Discipline:	Electronics and Telecommunication Engineering
Offered Multidisciplinary Minors:	• Innovation and Entrepreneurship • Biotechnology • IoT and Cloud Computing • Geographical Information System • VLSI • Artificial Intelligence
Years of Study:	04 Years
Semesters:	**Major –** 1, 2, 3, 4, 5, 6, 7, 8 **Multidisciplinary Minors** – 4, 5, 6
Credits:	174

Level 6: B.Tech. in Technology - Honors and Multidisciplinary Minor

Major Discipline:	Electronics and Telecommunication Engineering
Offered Honors and Multidisciplinary Minors:	**Honors:** • Internet of Things* • Artificial Intelligence & Machine Learning • Cyber Security • Virtual and Augmented Reality • Data Science • Blockchain **Multidisciplinary Minors:** • Innovation and Entrepreneurship • Biotechnology • IoT and Cloud Computing* • Geographical Information System • VLSI • Artificial Intelligence * Can be chosen for either Honors or Minors, not both
Years of Study:	04 Years
Semesters:	**Major –** 1, 2, 3, 4, 5, 6, 7, 8 **Multidisciplinary Minors** – 4, 5, 6 **Honors** – 5, 6, 7, 8
Credits:	192 (= Major with Multidisciplinary Minors: 174 + Honors: 18)

Level 6: B.Tech. in Technology - Honors with Research and Multidisciplinary Minor

Major Discipline:	Electronics and Telecommunication Engineering
Offered Multidisciplinary Minors:	• Innovation and Entrepreneurship • Biotechnology • IoT and Cloud Computing • Geographical Information System • VLSI • Artificial Intelligence
Years of Study:	04 Years
Semesters:	**Major –** 1, 2, 3, 4, 5, 6, 7, 8 **Multidisciplinary Minors** – 4, 5, 6 **Honors with Research** – 7, 8
Credits:	192 (= Major with Multidisciplinary Minors: 174 + Honors with Research: 18)

Level 6: B.Tech. in Technology with Double Minors (Multidisciplinary & Specialization)

Major Discipline:	Electronics and Telecommunication Engineering
Offered Multidisciplinary Minors and Specialization Minors:	**Multidisciplinary Minors:** • Innovation and Entrepreneurship • Biotechnology • IoT and Cloud Computing • Geographical Information System • VLSI • Artificial Intelligence **Specialization Minors:** 06 additional courses (of minimum 12 week each), in another Engg. / Tech. discipline / Emerging Areas through MOOC
Years of Study:	04 Years
Semesters:	**Major –** 1, 2, 3, 4, 5, 6, 7, 8 **Multidisciplinary Minors** – 4, 5, 6 **Specialization Minors** – 3, 4, 5, 6, 7, 8
Credits:	192 (= Major with Multidisciplinary Minors: 174 + Specialization Minors: 18)

Credit Distribution Structure for Four Year Multidisciplinary B.Tech. Degree Program in Electronics and Telecommunication Engineering with Multiple Entry Multiple Exit Options

Level	Semester	Faculty: Science and Technology					Faculty: Any	Vocational Skills (VS) & Skill Enhancement (SE) Courses		Ability Enhancement (AE), Indian Knowledge System (IKS), Value Education (VE) Courses			Field Projects / Community Engagement (CE) Projects, Internship (INT), and Co-curricular (CC) Courses			Credits	Cumulative Credits
		Basic Science (BS) Courses	Engineering Science (ES) Courses	Major / Professional Core (PC) Courses	Major / Professional Elective - Department-level (PE-DLC) Courses	Multi-disciplinary Minor (MM) Courses	Open Elective - Institute-level (OE-ILC) Courses	VS - SAT Courses	SE - SAT Courses	AE - SAT Courses	IKS - SAT Courses	VE - SAT Courses	CE - Project-Based Learning (PBL)	INT	CC - SAT Courses		
Level 4.5	I	9	8					1				1			2	21	42
	II	9	8					1		2	1					21	
Exit Option with UG Certificate in Technology with Additional 08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major																	
Level 5.0	III	4		15					1				1			21	85
	IV	4		11		4			1	1			1			22	
Exit Option with UG Diploma in Technology with Additional 08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major																	
Level 5.5	V			11	4	3			1			2	1			22	130
	VI			8	4	3	3	2					3			23	
Exit Option with Bachelor's Degree in Vocation (B. Voc.) with Additional 08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major																	
Level 6.0	VII			8	7		3						6			24	174
	VIII			8										12		20	
Total		**26**	**16**	**61**	**15**	**10**	**6**	**4**	**3**	**3**	**1**	**3**	**12**	**12**	**2**	**174**	

SEMESTER III

TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
EXC301	Applications of Mathematics in Engineering-I	3 – 0 – 1	04	3 – 0 – 1	04	BS
EXC302	Digital Logic Design	3 – 0 – 0	03	3 – 0 – 0	03	PC
EXC303	Electronic Devices & Linear Circuits	3 – 0 – 0	03	3 – 0 – 0	03	PC
EXC304	Electronic Instrumentation and Control System	3 – 0 – 0	03	3 – 0 – 0	03	PC
EXC305	Electrical Network Theory	3 – 0 – 0	03	3 – 0 – 0	03	PC
EXL302	Digital Logic Design Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
EXL303	Electronic Devices & Linear Circuits Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
EXL304	Electronic Instrumentation and Control System Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
EXPR31	Community Engagement PBL – Mini Project I (**Arduino board projects**.)	0 – 2 – 0	02[$]	0 – 1 – 0	01	PBL
EXXS37	Skill Enhancement – SAT VII: Skill-Based Learning (**C++ and Java Programming)**	0 – 2* – 0	02	0 – 1 – 0	01	SE-SAT
Total		**15 – 10 – 1**	**26**	**15 – 5 – 1**	**21**	

*SAT can be conducted as TH or P or both as required. [$]Load of learner, not the faculty.

EXAMINATION SCHEME

Course Code	Course Name	CA Marks			ESE		TW / O / P Marks				Total Marks
		T1	T2	T = T1 + T2	Marks	Duration (in Hrs)	TW	O	P	P& O	
EXC301	Applications of Mathematics in Engineering-I	20	20	40	60	2.5	25	-	-	-	125
EXC302	Digital Logic Design	20	20	40	60	2.5	-	-	-	-	100
EXC303	Electronic Devices & Linear Circuits	20	20	40	60	2.5	-	-	-	-	100
EXC304	Electronic Instrumentation and Control System	20	20	40	60	2.5	-	-	-	-	100
EXC305	Electrical Network Theory	20	20	40	60	2.5	-	-	-	-	100
EXL302	Digital Logic Design Laboratory	-	-	-	-	-	25	-	-	25	50
EXL303	Electronic Devices & Linear Circuits Laboratory	-	-	-	-	-	25	-	-	25	50
EXL304	Electronic Instrumentation and Control System Laboratory	-	-	-	-	-	25	-	-	-	25
EXPR31	Community Engagement PBL – Mini Project-I (**Arduino board projects**.)	-	-	-	-	-	25	-	-	25	50
EXXS37	Skill Enhancement – SAT VII: Skill-Based Learning (**C++ and Java Programming)**	-	-	-	-	-	25	-	-	-	25
Total		**100**	**100**	**200**	**300**	**-**	**150**	**-**	**-**	**75**	**725**

Course Code	Course Name	Credits (TH+P+TUT)
EXC301	**Applications of Mathematics in Engineering – I**	**3 + 0 + 1**
Prerequisite:	1. Engineering Mathematics-I 2. Engineering Mathematics-II 3. Scalar and Vector Product: Scalar and vector product of three and four vectors	
Course Objectives:	1. To learn the Laplace Transform, Inverse Laplace Transform of various functions and its applications. 2. To understand the concept of Fourier Series, its complex form and enhance the problem solving skill. 3. To understand the concept of complex variables, C-R equations, harmonic functions and its conjugate and mapping in the complex plane. 4. To understand the basics of Linear Algebra. 5. To use concepts of vector calculus to analyze and model engineering problems	
Course Outcomes:	Upon completion of the course, the learners will be able to: 1. Solve the real integrals in engineering problems using the concept of Laplace Transform. 2. Analyze engineering problems through the application of inverse Laplace transform of various functions. 3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems. 4. Solve the problems of obtaining orthogonal trajectories and analytic functions by means of complex variable theory and application of harmonic conjugate. 5. Use matrix algebra to solve the engineering problems. 6. Apply the concepts of vector calculus in real life problems.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02
1. Laplace Transform	1.1 Definition of Laplace transform, Condition of Existence of Laplace transform. Laplace Transform (L) of Standard Functions like e^{at}, $sin(at)$, $cos(at)$, $sinh\,(at)$, $cosh\,(at)$ and t^n, $n \geq 0$.	1	02	06
	1.2 Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by *t*, Division by *t*, Laplace Transform of derivatives and integrals (Properties without proof)		02	
	1.3 Evaluation of integrals by using Laplace Transformation.		02	
2. Inverse Laplace Transform	2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivatives.	2	02	07
	2.2 Partial fractions method to find inverse Laplace transforms.		03	
	2.3 Inverse Laplace transform using Convolution theorem (without proof).		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
3. Fourier Series	3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof).	3	01	06
	3.2 Fourier series of periodic function with period 2π and $2l$.		02	
	3.3 Fourier series of even and odd functions.		01	
	3.4 Fourier Transform-Fourier sine transform and Fourier cosine transform.		02	
4. Complex Variables	4.1 Function $f(z)$ of complex variable, limit, continuity and differentiability of $f(z)$Analytic function, necessary and sufficient conditions for $f(z)$ to be analytic (without proof).	4	03	07
	4.2 Cauchy-Riemann equations in Cartesian coordinates (without proof).		01	
	4.3 Milne-Thomson method to determine analytic function $f(z)$when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given		02	
	4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories.		01	
5. Linear Algebra: Matrix Theory	5.1 Characteristic equation, Eigen values and Eigen vectors, Example based on properties of Eigen values and Eigen vectors. (Without Proof).	5	02	06
	5.2 Cayley-Hamilton theorem (Without proof), Examples based on verification of Cayley- Hamilton theorem and compute inverse of Matrix.		02	
	5.3 Similarity of matrices, Diagonalization of matrices. Functions of square matrix		02	
6. Vector Differentiation and Integral	6.1 Vector differentiation: Basics of Gradient, Divergence and Curl (Without Proof).	6	02	07
	6.2 Properties of vector field: Solenoidal and irrotational (conservative) vector fields.		02	
	6.3 Vector integral: Line Integral, Green's theorem in a plane (Without Proof), Stokes' theorem (Without Proof) only evaluation.		03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Advanced engineering mathematics, H.K. Das, S . Chand, Publications 2. Higher Engineering Mathematics, B. V. Ramana, Tata Mc-Graw Hill Publication 3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication 4. Advanced Engineering Mathematics, Wylie and Barrett, Tata Mc-Graw Hill.
Reference Books	1. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series 2. Vector Analysis Murry R. Spiegel, Schaum's outline series, Mc-Graw Hill Publication 3. Beginning Linear Algebra, Seymour Lipschutz, Schaum's outline series, Mc-Graw Hill Publication 4. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Useful links:

1. http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=25
2. https://nptel.ac.in/noc/courses/111/
3. https://www.coursera.org/courses?query=mathematics
4. https://ndl.iitkgp.ac.in/

Continuous Assessment:

General Instructions:

1. Each Student has to write at least 6 class tutorials on the entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered a mini project in engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

   The distribution of Term Work marks will be as follows –

1.	Class Tutorials on entire syllabus	15 Marks
2.	Assignment	10 Marks

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1	20 marks
2.	Class Test 2	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Course Name	Credits (TH+P+TUT)
EXC302	**Digital Logic Design**	**3+0+0**
Prerequisite:	1. Basics of Electrical Engineering(BSC105) 2. Engineering Physics(BSC102)	
Course Objectives:	1. To understand number system representations and their inter-conversions used in digital electronic circuits. 2. To analyse digital logic processes and to implement logical operations using various combinational logic circuits. 3. To analyse, design and implement logical operations using various sequential logic circuits. 4. To study the characteristics of memory and their classification. 5. To learn basic concepts in VHDL and implement combinational and sequential circuits using VHDL.	
Course Outcomes:	1. Develop a digital logic and apply it to solve real life problems. 2. Analyse, design and implement combinational logic circuits. 3. Classify different semiconductor memories. 4. Analyse, design and implement sequential logic circuits. 5. Analyse digital system design using PLD. 6. Simulate and implement combinational and sequential circuits using VHDL.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Number Systems and Codes	Review of Binary, Octal and Hexadecimal Number Systems, their inter-conversion, Binary code, Gray code and BCD code, Binary Arithmetic, Addition, Subtraction using 1's and 2's Complement	1	--	04
2. Logic Family and Logic Gates	2.1 Difference between Analog and Digital signals, Logic levels, TTL and CMOS Logic families and their characteristics.	1	02	05
	2.2 Digital logic gates, Universal gates, Realization using NAND and NOR gates, Boolean Algebra, De Morgan's Theorem.		03	
3. Combinational Logic Circuits	3.1 SOP and POS representation, K-Map up to four variables and Quine-McClusky method for minimization of logic expressions.	2	04	12
	3.2 Arithmetic Circuits: Half adder, Full adder, Half Subtractor, Full Subtractor, Carry Look ahead adder and BCD adder, Magnitude Comparator.		04	
	3.3 Multiplexer and De-Multiplexer: Multiplexer operations, cascading of Multiplexer, Boolean function implementation using MUX, DEMUX and basic gates, Encoder and Decoder.		04	
4. Sequential Logic Circuits	4.1 Flip flops: RS, JK, Master slave flip flops; T & D flip flops with various triggering methods, Conversion of flip flops, Registers: SISO, SIPO, PISO, PIPO and Universal Shift Register.	4	04	12
	4.2 Counters: Asynchronous and Synchronous counters with State transition diagram, Up/Down, MOD N, BCD Counter.		04	
	4.3 Applications of Sequential Circuits: Frequency		04	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	division, Ring counter, Johnson counter, Introduction to design of Moore and Mealy circuits.			
5. Different Types of Memories and Programmable Logic Devices	5.1 Classification and Characteristics of memory, SRAM, DRAM, ROM, PROM, EPROM and Flash memories	3	01	04
	5.2 Introduction: Programmable Logic Devices (PLD), Programmable Logic Array (PLA), Programmable Array Logic (PAL)	5	03	
6. Introduction to VHDL	Basics of VHDL/Verilog Programming, Design and implementation of Adder, Subtractor, multiplexer and flip flop using VHDL/Verilog	6	--	02
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. John F. Warkerly, "Digital Design Principles and Practices", Pearson Education, Fifth Edition (2018). 2. Morris Mano, Michael D. Ciletti, "Digital Design", Pearson Education, Fifth Edition (2013). 3. R. P. Jain, "Modern Digital Electronics", Tata McGraw Hill Education, Fourth Edition (2010). 4. A. Anand Kumar, "Fundamentals of Digital Circuits", PHI, Fourth Edition (2016). 5. Volnei A. Pedroni, "Digital Electronics and Design with VHDL" Morgan Kaufmann Publisher, First Edition (2008). 6. Stephen Brown & Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", Third Edition, MGH (2014). Stochastic Processes", Tata McGraw Hill Education
Reference Books	1. Thomas L. Floyd, "Digital Fundamentals", Pearson Prentice Hall, Eleventh Global Edition (2015). 2. Mandal, "Digital Electronics Principles and Applications", McGraw Hill Education, First Edition (2010). 3. Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss "Digital Systems Principles and Applications", Ninth Edition, PHI (2009). 4. Donald P. Leach / Albert Paul Malvino/Gautam Saha, "Digital Principles and Applications", The McGraw Hill, Eight Edition (2015). 5. Stephen Brown & Zvonko Vranesic, "Fundamentals of Digital Logic Design with VHDL", Second Edition, TMH (2009). 6. J. Bhasker, "A Verilog HDL Primer", Star Galaxy Press, Third Edition (1997)
Useful Links:	1. Course: Digital Circuits By Prof. Santanu Chattopadhyay (IIT Kharagpur); https://swayam.gov.in/nd1_noc20_ee70/preview

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Course Name	Credits (TH+P+TUT)
EXC303	**Electronic Devices and Linear Integrated Circuits**	**3+0+0**

Prerequisite:	Basic Electrical Engineering
Course Objectives:	1. To understand the concepts, working principles and key applications of BJT and FET. 2. To perform analysis of circuits based on linear integrated circuits. 3. To design circuits and systems for particular applications using linear integrated circuits.
Couse Outcomes:	**After the completion of course students can able to:** 1. Outline and classify all types of electronics and integrated circuits. 2. Explain the fundamentals and areas of applications for the integrated circuits. 3.Design practical circuits that perform the desired operations 4. Compare theoretical & practical results in electronic and integrated circuits. 5. Identify the appropriate integrated circuit modules for designing engineering application. 6. Select and use an appropriate electronic and integrated circuit to build a given application.

Module No & Name	Sub Topics	CO Mapped	Hrs./ Subtopic	Hrs/ Topic
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02
1. Introduction of BJT and FET	Bipolar Junction Transistor (BJT): Principle of Operation, Common Emitter, Common Base and Common Collector Configurations, Transistor as a switch, switching times, Transistor Biasing and Stabilization - Operating point	1	04	08
	Introduction of MOSFET, MOSFET types, biasing in MOS amplifier circuit.		04	
2. Introduction to Operational Amplifier	Introduction to Differential Amplifier. Block diagram of Op-Amp. Ideal and practical characteristics of op-amp.	2	02	07
	Configurations of Op-Amp: Open loop and closed loop configurations of Op-amp, Inverting and Non-inverting configuration of Op-amp and buffer.		02	
	Summing amplifier, difference amplifiers and Instrumentation amplifier using Op-amp. (using 3 op amp)		03	
3. Linear Applications of Operational Amplifier	Voltage to current and current to voltage converter.	3	03	08
	Integrator & differentiator (ideal & practical), Active Filters: First and Second order active low pass, high pass		03	
	Positive feedback, Barkhausen's criteria, Sine Wave		02	

Module No & Name	Sub Topics	CO Mapped	Hrs./ Subtopic	Hrs/ Topic
	Oscillators: RC phase shift oscillator, Wien bridge oscillator.			
4. Non-Linear Applications of Operational Amplifier	Comparators: Inverting comparator, non-inverting comparator, zero crossing detectors, window detector,	4	02	07
	Schmitt Triggers: Inverting Schmitt trigger, non-inverting Schmitt trigger.		03	
	Waveform Generators: Square wave generator and triangular wave generator. Basics of Precision Rectifiers: Half wave and full wave precision rectifiers.		02	
5. Timer IC 555 and it's applications	Functional block diagram and working of IC 555	5	02	05
	Design of Astable and Monostable multivibrator using IC 555		03	
6. Special Purpose Integrated Circuits	Functional block diagram and working of VCO IC 566.	6	02	04
	Functional block diagram and working of PLL IC 565.		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
			Total:	**42**

Term Work:

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):
Two class tests of 20 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Course Name	Credits (TH+P+TUT)
EXC304	**Electronic Instrumentation & Control Systems**	**3+0+0**

Prerequisite:	1. Basic Electrical Engineering 2. Applied Physics
Course Objectives:	1. To provide basic knowledge about the various sensors and transducers 2. To provide fundamental concepts of control system such as mathematical modelling, time response and Frequency response 3. To develop concepts of stability and its assessment criteria.
Course Outcomes:	1. Identify various sensors, transducers and their brief performance specification 2. Explain the principle of working of various transducers used to measure temperature, displacement level, pressure and their applications in industry 3. Determine the models of physical systems in forms suitable for use in the analysis and design of control systems 4. Obtain the transfer functions for a given Control system 5. Apply the analysis of systems in the time domain and frequency domain. 6. Predict stability of a given system using appropriate criteria.

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Principle of Measurement, Testing and Measuring instruments	1.1 Introduction to Basic instruments: Components of generalized measurement system Concept of accuracy, precision, linearity, sensitivity, resolution, hysteresis, calibration	1	02	04
	1.2 Measurement of Resistance: Kelvin's double bridge, Wheatstone bridge and Megohm bridge. Measurement of Inductance: Maxwell bridge and Hey bridge Measurement of Capacitance: Schering bridge		02	
2. Sensors and Transducers	2.1 Basics of sensors and Transducers-Active and passive transducers, characteristics and selection criteria of transducers	2	02	06
	2.2 Displacement and pressure- Potentiometers, pressure gauges, Linear Variable Differential Transformers (LVDT) for measurement of pressure and displacement strain gauges		02	
	2.3 Temperature Transducers- Resistance Temperature Detectors (RTD). Thermistors and thermocouples, their ranges and applications		02	
3. Introduction to control system Analysis	3.1 Introduction: Open and closed loop systems, example of control systems, Introduction of Adaptive Control System	3	01	08
	3.2 Modelling: Modelling OF Electrical System, Transfer function model		02	
	3.3 Block diagram reduction techniques and Signal		05	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	flow graph			
4. Response of control system	4.1 Dynamic Response: Standard test signals, transient and steady state behaviour of first and second order systems, steady state errors in feedback control systems and their types.	4	02	04
	4.2 Concept of lag and lead compensator		02	
5. Stability Analysis in Time Domain	5.1 Concept of stability: Routh and Hurwitz stability criterion.	5	02	08
	5.2 Root locus Analysis: Root locus concept, general rules for constructing root-locus, root locus analysis of control system		06	
6. Stability Analysis in frequency domain	6.1 Introduction: Frequency domain specification, Relationship between time and frequency domain specification of system, stability margins	6	03	09
	6.2 Bode Plot: Magnitude and phase plot, Method of plotting Bode plot, Stability margins and analysis using bode plot. Frequency response analysis of RC, RL, RLC circuits		04	
	6.3 Nyquist Criterion: Concept of Polar plot and Nyquist plot, Nyquist stability criterion, gain and phase margin		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. A.K. Sawhney, "*Electrical & Electronic Measurement & Instrumentation"* – DRS. India 2. B.C Nakra, K.K. Chaudhary, Instrumentation Measurement and Analysis, Tata Mc Graw Hill. 3. W.D. Cooper, "*Electronic Instrumentation and Measuring Techniques"* –PHI 4. Nagrath, M. Gopal, "*Control System Engineering*", Tata McGraw-Hill
Reference Books	1. Helfrick & Cooper, "*Modern Electronic Instrumentation & Measuring Techniques"* – PHI 2. M.M.S. Anand, "*Electronic Instruments and Instrumentation Technology"*. 3. Gopal M., "*Control Systems Principles and Design*", Tata McGraw Hill Publishing Co. Ltd. New Delhi, 1998 4. Benjamin C. Kuo, "*Automatic Control Systems*, Pearson Education", VIIth edition
Useful Links:	
NPTEL/ Swayam Course: Course: Control Systems By Prof. C. S. Shankar Ram (IIT Madras); https://swayam.gov.in/nd1_noc20_ee90/preview	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Course Name	Credits (TH+P+TUT)
EXC305	**Electrical Network Theory**	**3 + 0 + 0**
Prerequisites	1. Basic Electrical Engineering 2. Matrix (Engineering Mathematics-I), Solutions to Differential Equation, Integration (Engineering Mathematics- II), Laplace Transform (Applications of Mathematics in Engineering -I)	
Course Objectives:	1. To explain the basic concepts and Theorems of electrical networks withDependent Source and solve them using mesh and nodal analysis techniques 2. To introduce students with the fundamental concepts in graph theory 3. To analyze the Circuits in Time and Frequency domain 4. To introduce open circuit, short circuit, transmission, hybrid parameters. 5. To study concepts of driving point and transfer functions, poles and zeros,Hurwitz polynomial of Network Functions. 6. To study positive real functions from given functions	
Course Outcomes:	After successful completion of the course, student will be able to 1. Articulate knowledge in analyzing Circuits by using Network theorems withDependent source. 2. Illustrate the complex electric circuits by converting them into GraphTheory. 3. Apply Time domain and frequency domain analysis of RLC Circuits 4. Synthesize the various parameters of two port network 5. Recognize Hurwitz polynomials from a given function. 6. Integrate positive real function from given function	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02
1. Analysis of DC circuits	1.1 Analysis of DC circuits: Analysis of circuits with dependent sources using generalized Mesh, Node, Super mesh, Super node analysis.	1	04	08
	1.2 Circuit Theorems: Superposition Theorem, Thevenin Theorem, Norton Theorem, Maximum Power Transfer Theorem. (Use only DC source).		04	
2. Graph Theory	2.1 Concept of Node and Loop, Tree, Co-tree, Incidence matrix: Complete Incidence matrix, Reduced Incidence matrix, number of possible trees of graph	2	02	05
	2.2 Cut Set Matrix and Tie Set Matrix		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
3. Time domain and frequencydomain analysis of R- L-C circuits	3.1 Time domain analysis of R-L and R-C Circuits: Forced and natural response, initialand final values. Solution using first order and second order differential equations with step signals.	3	03	07
	3.2 Frequency domain analysis of R-L-C Circuits: Forced and natural response, Solution using second order equation for step signal, Effect of damping factor (No Numerical)		04	
4. Two portNetworks	4.1 Open Circuit, Short Circuit, and Transmission and Hybrid parameters.	4	06	07
	4.2 Relationships among parameters (No Derivations),Conditions for reciprocity and symmetry.		01	
5. NetworkFunction	5.1 Driving point function and Transfer function, Necessary conditions for Driving point functions and Transfer functions, Poles and Zeros of Network functions, Hurwitz Polynomials Properties of Hurwitz Polynomials, Testing for Hurwitz polynomials.Efficiency.	5	06	06
6. Positive Real Functions	6.1 Positive Real Functions, Properties of Positive Real Functions, Necessaryand sufficient conditions for positive real functions. Testing for positive real functions.	6	04	04
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Franklin F Kuo, "Network Analysis and Synthesis", Wiley Toppan, 2nd edition, 1966. 2. M E Van Valkenburg, "Network Analysis", Prentice-Hall of India Pvt Ltd, New Delhi, 26th Indian Reprint, 2000ill
Reference Books	1. A. Sudhakar, Shyam mohan S. Palli "Circuits and Networks", Tata McGraw-Hill education, 2010 2. Smarajit Ghosh "Network Theory Analysis & Synthesis", PHI learning 3. K.S. Suresh Kumar, "Electric Circuit Analysis" Pearson, 2013. 4. D. Roy Choudhury, "Networks and Systems" , New Age International, 1998 5. C. K. Alexander and M. N. O. Sadiku," Fundamental of Electric Circuit" McGraw Hill Education, India, 2013
Useful Links:	Analog signals, Network and measurement Virtual Laboratory: vlabs.iitkgp.ac.in/asnm/#

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Lab Code	Lab Name	Credits (P+TUT)
EXL302	**Digital Logic Design Laboratory**	**1+0**
Lab Prerequisite:	1. Basics of Electrical Engineering(BSC105) 2. Engineering Physics(BSC102)	
Lab Objectives:	1. To understand number system representations and their inter-conversions used in digital electronic circuits. 2. To analyse digital logic processes and to implement logical operations using various combinational logic circuits. 3. To analyse, design and implement logical operations using various sequential logic circuits. 4. To study the characteristics of memory and their classification. 5. To learn basic concepts in VHDL and implement combinational and sequential circuits using VHDL.	
Lab Outcomes:	1. Verify logic gates. 2. Implement combinational logic circuits. 3. Implement sequential logic circuits. 4. Simulate basic logic gates using VHDL. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.	

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02
1.	Verify operations of logic gates and Boolean function.	1, 5, 6	02
2.	Verify operations of universal gates NAND and NOR.	1, 5, 6	02
3.	Implement and design Binary to Gray and Gray to Binary.	1, 5, 6	02
4.	Implement and design half adder & subtractor and full adder & subtractor circuits.	2, 5, 6	02
5.	Implement and design BCD Adder.	2, 5, 6	02
6.	Design and Implement logic equation using multiplexer.	2, 5, 6	02
7.	Implement and Design digital Encoder circuit.	1, 5, 6	02
8.	Design and verify the truth table of various flip flops (FF) like SR, JK, D and T flip-flops.	3, 5, 6	02
9.	Simulate AND, OR and NAND logic gate operation using Verilog Hardware Description Language.	4, 5, 6	02
10.	Simulate Decoder using VHDL code.	5, 6	02
11.	Simulate positive edge triggered D flip flop with asynchronous active low preset and clear using VHDL	5, 6	02

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
	code.		
12.	Simulate the counter using VHDL code.	5, 6	02
13.	Case Study / Mini Project	1 to 6	02
		Total	**28**

Useful Links:
1. http://vlabs.iitkgp.ac.in/dec/#
Term work: 1. Term work should consist of a minimum of 8 experiments. 2. Journal must include assignments on content of theory and practical of the course. 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4.Total 25 Marks (Experiments: 15-marks, Assignments/Case study/Project/demo/presentation: 10-marks)
Oral/Practical/P&O: Practical and **oral** examination will be based on the experiment list and content of the entire theory syllabus and carries 25-Marks

Lab Code	Lab Name	Credits (P+TUT)
EXL303	**Electronic devices & Linear Integrated Circuits Lab**	(1+0)
Lab Prerequisite:	1.Basic Electrical Engineering 2. Electronic Devices & Circuits	
Lab Objectives:	1. To teach fundamental principles of standard electronic Circuits & integrated circuits. 2. To develop a overall approach for students from selection of Electronic & integrated circuit, study its specification, the functionality, design and practical applications	
Lab Outcomes (LOs):	1. Demonstrate an understanding of fundamentals of Electronic & integrated circuits. 2.Analyze the various applications and circuits based on particular linear integrated circuit. 3. Explain the differences between theoretical, practical and simulated results in Electronic and integrated circuits. 4. Apply the knowledge to do simple mathematical operations. 5.Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.	

Lab No	Experiment Title	LO mapped	Hrs/Lab
1	Study BJT characteristics.	**1,5,6**	**2**
2	Study MOSFET Characteristics.	**1,5,6**	**2**
3	Design BJT as Biasing.	**1,5,6**	**2**
6	Design MOSFET as Biasing.	**1,5,6**	**2**
5.	Design inverting, non-inverting amplifier and buffer using IC 741.	**1,5,6**	**2**
6.	Design summing and difference amplifier using op-amp.	**1,5,6**	**2**
7.	Design voltage to current converter with grounded load.	**1,5,6**	**2**
8.	Design and analyse linear Application of opamp like, integrator and differentiator.	**1,5,6**	**2**
9.	Design Schmitt trigger using Op-amp.	**2,5,6**	**2**
10.	Design Wein bridge and RC phase shift Oscillator.	**2,5,6**	**2**
11.	Design and analyse second order High pass and Low pass filter	**2,5,6**	**2**
12.	Design Astable multivibrator using IC 555 for fixed frequency and variable duty cycle.	**2,5,6**	**2**
13.	Design Monostable Multivibrator using IC 555.	**2,5,6**	**2**
14.	Design Instrumentation amplifier using 3 Op-Amp.	**4,5,6**	**2**
15.	Design Precision rectifier (HWR & FWR)	**4,5,6**	**2**
16.	Design Square & Triangular wave generator USING OP AMP	**4,5,6**	**2**

Term work:
1. Term work should consist of a minimum of 10 experiments **2.** Journal must include assignments on content of theory and practical of the course **3.** The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
Oral/Practical/P&O: **Oral & Practical examination** will be based on experiment list and performance of experiment.

Lab Code	Lab Name	Credits (P+TUT)
EXL304	**Electronic Instrumentation and Control System Lab**	**1+0**

Lab Prerequisite:	1. Basic Electrical Engineering 2. Applied Physics
Lab Objectives:	1. To experimentally verify the principle and characteristics of various transducers and measurement of resistance and inductance 2. To make students understand the construction and the working principle of various transducers used for Displacement measurement, Temperature measurement and Level measurement. 3. To examine steady-state and frequency response of the Type 0, 1, and 2 systems 4. To examine steady-state and frequency response of first and second order electrical systems. 5. To inspect stability analysis of a system using Root locus, Bode plot, polar plot and Nyquist plot.
Lab Outcomes:	1. Analyse Plot and validate the performance characteristics of transducers. 2. Validate the characteristics of various temperature, pressure and level transducers. 3. Analyse Plot frequency response of first-order electrical system. 4. Analyse Plot time response of second-order electrical systems and calculate the steady-state error. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO Mapped	Hrs./ Lab
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02
1.	Designing DC bridge for Resistance Measurement (Quarter, Half and Full bridge)	1, 5, 6	02
2.	Designing AC bridge Circuit for capacitance measurement.	1, 5, 6	02
3.	Study and characteristics of Resistive Temperature Detector (RTD).	2, 5, 6	02
4.	Study of Linear Variable Differential Transformer (LVDT)	2, 5, 6	02
5.	To plot the effect of time constant on first-order systems response.	3, 5, 6	02
6.	To plot the frequency response of first-order System	3, 5, 6	02
7.	To plot the time response of second-order systems	3, 5, 6	02
8.	To plot the frequency response of second-order System	3, 5, 6	02
9.	To Examine Steady State Error for Type 0, 1, 2 System	4, 5, 6	02

Lab No.	Experiment Title	LO Mapped	Hrs./ Lab
10.	To study the performance of Lead and Lag Compensator	4, 5, 6	02
11.	To inspect the relative stability of systems by Root-Locus using Simulation Software	3, 5, 6	02
12.	To determine the frequency specification from Polar plot of system	4, 5, 6	02
13.	To inspect the stability of system by Nyquist plot using Simulation software	4, 5, 6	02
14.	To inspect the stability of the system by Bode plot using Simulation software.	3, 5, 6	02
15.	Any other experiment based on syllabus which will help students to understand the topic/concept.		02
		Total	**32***
***Minimum 28 Hrs. Lab / Mini Project to be conducted**			

Useful Links:
1. http://slcoep.vlabs.ac.in/List%20of%20experiments.html?domain=Electrical%20Engineering 2. http://vlabs.iitkgp.ernet.in/asnm/#
Term work: 1. Term work should consist of a minimum of 8 experiments. 2. Journal must include assignments on content of theory and practical of the course. 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Assignments/Case study/Project/demo/presentation: 10-marks)

Course code	Project Based Learning	Credits (TH+P+TUT)
EXPR31	**Community Engagement PBL – Mini Project I (Arduino Board Projects)**	**0+1+0**

Objectives:

1. To acquaint yourself with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint yourself with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcomes:

Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inference from available results through theoretical/ experimental/simulations
5. Analyze the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9. Demonstrate project management principles during project work.

General Guidelines for Mini Project I and II:	
1	Students shall form a group of 2 to 4 students, while forming a group shall not be allowed less than two or more than four students, as it is a group activity.
2	Students should do surveys and identify needs, which shall be converted into problem statements for mini projects in consultation with faculty supervisor/internal committee of faculties.
3	Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini projects.
4	A logbook to be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.
5	Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
6	Students in a group shall understand problems effectively, propose multiple solutions and select the best possible solution in consultation with the guide/ supervisor.
7	Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
8	The solution to be validated with proper justification and report to be compiled in standard format of the college.

General Guidelines for Mini Project I and II:	
9	With the focus on self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV.
10	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis. **Note: Project Should More Towards Societal Based And Health Care Based.**

Term Work:		
The review/ progress monitoring committee shall be constituted by senior faculty members. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester. Assessment also considers peer review and ethics observed by faculties and participation involvement.		
In continuous assessment focus shall also be on each individual student, log book maintained and weekly meeting based on the same.		
Distribution of Term work marks for both semesters shall be as below:		**Practical Marks**
1	Marks awarded by guide/supervisor based on implementation	10
2	Peer assessment by team members	05
3	Marks awarded by review committee	05
4	Quality of Project report	05
Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines		
One-year project:		
1	In the first semester the entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on the presentation given by the student group. ● First shall be for finalization of problem ● Second shall be on finalization of the proposed solution of the problem.	
2	In the second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. ● First review is based on readiness of building working prototypes to be conducted. ● Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.	
Half-year project:		
1	In this case in one semester students' group shall complete project in all aspects including, ● Identification of need/problem ● Proposed final solution ● Procurement of components/systems ● Building prototype and testing	
2	Continuous assessment will be weekly based on a logbook. Two presentations will be	

	conducted for review before a panel. ● First shall be for finalization of problem and proposed solution ● Second shall be for implementation and testing of solutions.
Assessment criteria of Mini Project	
Mini Project shall be assessed based on following criteria;	
1	Quality of survey/ need identification
2	Clarity of Problem definition based on need.
3	Innovativeness in solutions
4	Feasibility of proposed problem solutions and selection of best solution
5	Cost effectiveness
6	Societal impact
7	Innovativeness
8	Cost effectiveness and Societal impact
9	Full functioning of working model as per stated requirements
10	Effective use of skill sets
11	Effective use of standard engineering norms
12	Contribution of an individuals as member or leader
13	Clarity in written and oral communication
In **one year, project**, first semester evaluation may be based on the first six criteria and the remaining may be used for the second semester evaluation of performance of students in the mini project.	
In the case of a half **year project** all criteria's in generic may be considered for evaluation of performance of students in a mini project.	
Guidelines for Assessment of Mini Project Practical/Oral Examination:	
1	Report should be prepared as per the guidelines issued by the University of Mumbai.
2	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
3	Students shall be motivated to participate in poster, project competition on the work in students' competitions.
Mini Project shall be assessed based on following points;	
1	Quality of problem and Clarity
2	Innovativeness in solutions
3	Cost effectiveness and Societal impact
4	Full functioning of working model as per stated requirements
5	Effective use of skill sets
6	Effective use of standard engineering norms
7	Contribution of an individuals as member or leader
8	Clarity in written and oral communication

Project Based Learning Code	Project Based Learning Course Name	Credits (TH+P+TUT)
EXPR31	**Community Engagement PBL – Mini Project I (Arduino board projects.)**	**0+1+0**
Mini Project Prerequisite:	1. Mini-Project 1- PBL 2. C++ and Java Programming 3. 3. Electronic Devices and Circuit	
Mini Project Objectives:	1. To make students familiar with the basics of Electronics, Microcontroller, Arduino board. 2. To familiarize the students with the programming and interfacing of different devices with Arduino Board. 3. To increase students critical thinking ability and provide solutions to some real time problems.	
Mini Project Outcomes:	After successful completion of the course student will be able to: 1. Write basic codes for the Arduino board using the IDE for utilizing the onboard resources. 2. Apply the knowledge of interfacing different devices to the Arduino board to accomplish a given task. 3 Design Arduino based projects for a given problem 4. Write code using python language using IDE for utilizing the onboard resources. 5 Apply the knowledge of interfacing different devices to Arduino board to accomplish a given task. 6. Design Arduino based projects for a given problem.	

Experiment No.	Unit No.	Arduino Board	Hrs.	PRO mapped
EX.1.0		**Introduction to Arduino Board**	**02**	**1**
	1.1	Introduction to Arduino Uno board and integrated development environment (IDE)		
	1	Write the code for blinking the on board led with a specified delay Apparatus Requirement: Hardware: Arduino Board LED, Software: Arduino IDE Software.		
EX.2.0		**GPIO (along with Analog pin) Programming**	**04**	**1**
	2.1	Introduction to programming GPIO, Analog and PWM PINS.		
	1	Interface any Digital Sensors to the Arduino board and display sensor values on serial Monitor.		
	2	Interface any Analog sensor to the Arduino board and display sensor values on serial Monitor.		
	3.	Generate varying duty cycle PWM using Arduino.		
EX.3.0		**Controlling output devices/Displaying**	**04**	**2**
	3.1	Introduction to different sensor (Analog and Digital), Relays, Motors and display.		
	1	Interface an Analog Sensors to the Arduino board and display sensor values on LCD/TFT/Seven segment Display.		
	2	Interface a temperature sensor to Arduino and switch on a relay to operate a fan if temperature exceeds given threshold. Also display the temperature on any of the display device		

EX.4.0		**Interfacing Communication Devices and Cloud Networking**	**04**	**2**
	4.1	Introduction to Bluetooth, Zigbee, RFID and WIFI, specifications and interfacing methods.		
	1	Interface Wi-Fi /Bluetooth/GSM/Zigbee/RF module to Arduino and program it to transfer sensor data wirelessly between two devices. Any two techniques from the above-mentioned modules needs to be interfaced.		
5.0		**Sample Projects**	**10**	**2**
	1.	Waste Management System		
	2.	Smart City Solutions		
	3.	Energy Monitoring Systems		
	4.	Smart Classrooms and learning Solutions		
	5.	Home security systems		
	6.	Smart Agriculture solutions		
	7.	Healthcare solutions.		
	8.	Industrial Applications		
	9.	IoT Applications		
	10.	Robotics		
		Total Hrs.	**24**	
*** Preferably the Project should be based on Arduino Boards**				

Reference Books:

1. Simon Monk, "Hacking Electronic: Learning Arduino and Raspberry Pi", McGraw-Hill Education TAB; 2 edition (September 28, 2017).
2. Programming Arduino: Getting Started with Sketches (second edition).
3. Arduino Workshop: A Hands-On Introduction with 65 Projects 1st Edition.
4. Arduino Cookbook.
5. Arduino Programming in 24 Hours, Sams Teach Yourself.

Useful learning Links:

Suggested Software tools:

1. Win32 Disk Imager: https://sourceforge.net/projects/win32diskimager/
2. SD Card Formatter: https://www.sdcard.org/downloads/formatter/
3. Arduino IDE: https://www.arduino.cc/en/main/software

Online Repository:

1. GitHub
2. NPTEL Videos on Arduino Programming.
3. Spoken Tutorial Project-IIT Bombay: https://spoken-tutorial.org/tutorial- search/?search_foss=Arduino&search_language=English
4. Teachers are recommended to use a free online simulation platform "Tinkercad" for the simulation of Arduino based circuits before the students implement it in the hardware: ht://www.tinkercad.com

Term Work (25 Marks):

The review/ progress monitoring committee shall be constituted by senior faculty members. The progress of the mini project to be evaluated on a continuous basis, minimum two reviews in each semester. Assessment also considers peer review and ethics observed by faculties and participation involvement.

In continuous assessment focus shall also be on each individual student, log book maintained and weekly meeting based on the same.		
Distribution of Term work marks for both semesters shall be as below:		**Practical Marks**
1	Marks awarded by guide/supervisor based on implementation	10
2	Peer assessment by team members	05
3	Marks awarded by review committee	05
4	Quality of Project report	05
Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines		
Oral/Practical/P&O: Oral & Practical examination will be based on the project demonstration		

Skill Based Learning Code	Skill Enhancement - SAT VII: Skill-Based Learning	Credits (TH+P+TUT)
EXXS37	**C++ and Java Programming**	**0+1+0**
Skill Prerequisite:	1. C-Programming (Structured Programming Approach)	
Skill Objectives:	1. To describe the principles of Object Oriented Programming (OOP) 2. To describe and understand decision making, looping structure for effective programming 3. To understand and apply concept of classes and objects, inheritance and interfaces 4. To understand and develop program using multithreading and Applet	
Skill Outcomes:	1. Apply the basic principles of OOP. 2. Apply decision making, looping structure for effective programming. 3. Implement the concept of classes and objects, inheritance and interfaces 4. Apply the concept of multithreading in object oriented programming and Using Applet solve real world problems. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.	

Module No.	Module Title	SO Mapped	Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02
Write C++ Program to			
1.	Print Number Entered by User	1	02
2.	Swap Two Numbers	1	02
3.	Check Whether Number is Even or Odd	2	02
4.	Find Largest Number Among Three Numbers	2	02
5.	Create a Simple class and Object	3	02
6.	Create an object of a class and access class attributes	3	02
7.	Create class methods	3	02
8.	Create a class to read and add two distance	3	02
9.	Create a class for student to get and print details of a student	3	02
10.	Demonstrate an example of friend function with class.	3	02
11.	Implement inheritance.	3	02
Write JAVA Program to			
1.	Display addition of number using command line Argument	1	02
2	Accept marks from user, if Marks greater than 40,declare the student as “Pass” else “Fail”	1	02
3	Write a program to demonstrate call by value and call by	3	02

Module No.	Module Title	SO Mapped	Hrs/ Module
	reference.		
4	Display sum of first 10 even numbers using do-while loop.	2	02
5	Display Multiplication table of 15 using while loop	2	02
6	Display basic calculator using Switch Statement.	2	02
7	Write a program to find the factorial of a number, using a recursive function.	3	02
8	Illustrate method of overloading	3	02
9	Demonstrate Parameterized Constructor	3	02
10	Write a program to find the area of a circle using Single Inheritance such that the base class method accepts the radius and the derived class method calculates and displays area.	3	02
11	Create thread by implementing 'runnable' interface or creating 'Thread Class	4	02
12	Write an applet to draw different shapes using colors (Applet)	4	02
		Total	**48***

***Minimum 28 Hrs. Lab / Mini Project to be conducted**

Text Books:

1. Bjarne Stroustrup, “The C++ Programming language”, Third edition, Pearson Education.
2. Yashwant Kanitkar, “Let Us Java”, 2nd Edition, BPB Publications.
3. D.T. Editorial Services, “Java 8 Programming Black Book”, Dreamtech Press, Edition: 2015
4. Deitel, “C++ How to Program”, 4th Edition, Pearson Education.

Reference Books:

1. Herbert Schidt, “The Complete Reference”, Tata McGraw-Hill Publishing Company Limited, Ninth Edition.
2. Java: How to Program, 8/e, Dietal, PHI
3. Grady Booch, James Rumbaugh, Ivar Jacobson, “The Unified Modeling Languageser Guide”, Pearson Education
4. Sachin Malhotra, Saurabh Chaudhary “Programming in Java”, Oxford University Press, 2010.

Useful Links:

1. CodeBlock:http://www.codeblocks.org/
2. Netbeans:https://netbeans.org/downloads/
3. Eclipse: https://eclipse.org/
4. Raptor-Flowchart Simulation :http://raptor.martincarlisle.com/

Term Work (25 Marks):

Term Work shall be awarded based on Assessment Rubrics.

Program Structure for Second Year UG Technology (EX)

SEMESTER IV

TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
EXC401	Applications of Mathematics in Engineering-II	3 – 0 – 1	04	3 – 0 – 1	04	BS
EXC402	Analog and Digital Communication Engineering	3 – 0 – 0	03	3 – 0 – 0	03	PC
EXC403	Microcontrollers	3 – 0 – 0	03	3 – 0 – 0	03	PC
EXC404	Signals and Systems	3 – 0 – 0	03	3 – 0 – 0	03	PC
MMC405	Multidisciplinary Minor Course	3 – 0 – 0	03	3 – 0 – 0	03	MM
EXL402	Analog and Digital Communication Engineering Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
EXL403	Microcontrollers Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
MML405	Multidisciplinary Minor Lab	0 – 2 – 0	02	0 – 1 – 0	01	MM
EXPR42	Community Engagement PBL – Mini Project II **(Raspberry Pi based projects).**	0 – 2 – 0	02[$]	0 – 1 – 0	01	PBL
EXXS48	Skill Enhancement – SAT VIII: Skill-Based Learning (**Python Programming)**	0 – 2[*] – 0	02	0 – 1 – 0	01	SE-SAT
EXXS49	Ability Enhancement – SAT IX: Skill-Based Learning **(Foreign and Indian Modern Languages-II)**	0 – 2[*] – 0	02	0 – 1 – 0	01	AE-SAT
Total		**15 – 12 – 1**	**28**	**15 – 6 – 1**	**22**	

[*]SAT can be conducted as TH or P or both as required.

[$]Load of learner, not the faculty.

SEMESTER IV

EXAMINATION SCHEME

Course Code	Course Name	CA Marks			ESE		TW / O / P Marks				Total Marks
		T1	T2	T = T1 + T2	Marks	Duration (in Hrs)	TW	O	P	P&O	
EXC401	Applications of Mathematics in Engineering-II	20	20	40	60	2.5	25	-	-	-	125
EXC402	Analog and Digital Communication Engineering	20	20	40	60	2.5	-	-	-	-	100
EXC403	Microcontrollers	20	20	40	60	2.5	-	-	-	-	100
EXC404	Signals and Systems	20	20	40	60	2.5	-	-	-	-	100
MMC405	Multidisciplinary Minor Course	-	-	-	-	-	50	50	-	-	100
EXL402	Analog and Digital Communication Engineering Laboratory	-	-	-	-	-	25	-	-	25	50
EXL403	Microcontrollers Laboratory	-	-	-	-	-	25	-	25	-	50
MML405	Multidisciplinary Minor Lab	-	-	-	-	-	25	-	-	-	25
EXPR42	Community Engagement PBL – Mini Project II **(Raspberry Pi based projects)**	-	-	-	-	-	25	-	-	25	50
EXXS48	Skill Enhancement – SAT VIII: Skill-Based Learning (**Python Programming)**	-	-	-	-	-	25	-	-	-	25
EXXS49	Ability Enhancement – SAT IX: Skill-Based Learning **(Foreign and Indian Modern Languages-II)**	-	-	-	-	-	25	-	-	-	25
Total		**80**	**80**	**160**	**240**	-	**225**	**50**	**25**	**50**	**750**

Course Code	Course Name	Credits (TH+P+TUT)
EXC401	**Applications of Mathematics in Engineering -II**	**3+0+1**
Prerequisite:	1. Engineering Mathematics-I 2. Engineering Mathematics-II 3. Applications of Mathematics in Engineering-I & Binomial Distribution	
Course Objectives:	1. To understand line and contour integrals and expansion of complex valued functions in a power series. 2. To understand the basic techniques of statistics for data analysis, Machine learning and AI. 3. To understand probability distributions and expectations. 4. To understand the concepts of vector spaces used in the field of machine learning and engineering problems. 5. To understand the concepts of Quadratic forms and Singular value decomposition. 6. To understand the concepts of Calculus of Variations.	
Course Outcomes:	1. Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals. 2. Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning and AI. 3. Apply the concepts of probability and expectation for getting the spread of the data and distribution of probabilities. 4. Apply the concept of vector spaces and orthogonalization process in Engineering Problems. 5. Use the concept of Quadratic forms and Singular value decomposition which are very useful tools in various Engineering applications. 6. Find the externals of the functional using the concept of Calculus of variation	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02
1. Complex Integration	1.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof)	1	03	07
	1.2 Taylor's and Laurent's series (without proof).		02	
	1.3 Definition of Singularity, Zeroes, poles of f(z), Residues, Cauchy's Residue Theorem (without proof).		02	
2. Statistical Techniques	2.1 Cla Karl Pearson's Coefficient of correlation (r)	2	01	06
	2.2 Spearman's Rank correlation coefficient (R) (repeated and non-repeated ranks)		01	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	2.3 Lines of regression		02	
	2.4 Fitting of first and second degree curves		02	
3. Probability Distributions	3.1 Baye's Theorem, Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function	3	02	07
	3.2 Expectation, mean and variance		02	
	3.3 Probability distribution: Poisson & normal distribution		03	
4. Linear Algebra: Vector Spaces	4.1 Vectors in n-dimensional vector space, norm, dot product, The Cauchy-Schwarz inequality (with proof), Unit vector	4	02	06
	4.2 Orthogonal projection, Orthonormal basis, Gram-Schmidt process for vectors		02	
	4.3 Vector spaces over real field, Subspaces.		02	
5. Linear Algebra: Quadratic Forms	5.1 Quadratic forms over real field, Linear Transformation of Quadratic form, Reduction of Quadratic form to diagonal form using congruent transformation.	5	01	07
	5.2 Rank, Index and Signature of quadratic form, Sylvester's law of inertia, Value class of a quadratic form-Definite, Semi definite and Indefinite		02	
	5.3 Reduction of Quadratic form to a canonical form using congruent transformations		02	
	5.4 Singular Value Decomposition		02	
6. Calculus of Variations	6.1 Euler- Lagrange equation (Without Proof), When F does not contain y, When F does not contain x, When F contains x, y, y'	6	02	06
	6.2 Isoperimetric problems- Lagrange Method		02	
	6.3 Functions involving higher order derivatives: Rayleigh-Ritz Method		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization	-	01	01
			Total:	**42**

Books:	
Text Books	1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication 2. Advanced engineering mathematics H.K. Das, S. Chand, Publications. 3. Higher Engineering Mathematics B. V. Ramana, Tata Mc-Graw Hill Publication.
Reference Books	1. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education. 2. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education. 3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication 4. Advanced Engineering Mathematics Wylie and Barret, Tata McGraw Hill. 5. Beginning Linear Algebra Seymour Lipschutz Schaum's outline series, Mc-Graw Hill Publication
Useful Links:	1. https://nptel.ac.in/courses/111/108/111108066/ 2. https://nptel.ac.in/courses/111/103/111103070/ 4. https://nptel.ac.in/courses/111/105/111105041/ 5. https://www.coursera.org/learn/complex-analysis

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Course Name	Credits (TH+P+TUT)
EXC402	**Analog and Digital Communication**	**3 + 0 + 0**
Prerequisites	1. Applications of Mathematics in Engineering-I 2. Applications of Mathematics in Engineering-II 3. Electronics Devices & Circuits	
Course Objectives:	1. To understand various analog modulation techniques. 2. To explain the key concepts of analog and digital pulse modulation. 3. To describe analog receivers and Multiplexers. 4. To describe basics of digital communication, receivers for digital signals and noise affecting it. 5. To learn different digital modulation and demodulation techniques. 6. To describe the basics of information theory, source coding and to illustrate various error control codes.	
Course Outcomes:	1. Solve numerical based on analog modulation and demodulation techniques. 2. Describe various pulse modulation and demodulation techniques. 3. Explain AM, FM receivers and multiplexing techniques. 4. Apply noise reduction techniques to improve the reception quality of digital signals in the presence of noise. 5. Compare the performances of different digital modulation techniques. 6. Apply the concepts of information theory in source coding and error control coding schemes.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction	-		02
1. Analog Communication	1.1. Introduction to Communication Systems: Principle concept of Amplitude modulation, Mathematical expression for AM Envelope, Frequency spectrum and Bandwidth, AM power distribution, Numerical on AM. Introduction to different types of AM. Explain AM Modulation and Demonstration techniques	1	03	06
	1.2. Angle Modulation: Concept, FM and PM waveform, Mathematical expression for FM and PM, Frequency and Phase deviation, Modulation index, Frequency spectrum of Angle modulated waves, Bandwidth requirement. Explain FM Modulation and Demodulation technique (any one). Numerical on FM parameters.		03	
2. Pulse Modulation	2.1 Apply the concept of Sampling Theorem to various understand digital pulse modulation and demodulation techniques like PAM, PWM, and PPM	2	02	05
	2.2 PCM technique, Quantization, Companding in PCM (u-law, a-law),		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	2.3 Concept of Delta Modulation and Adaptive delta modulation, Generation and detection with waveform and drawbacks		01	
3. Radio Receiver and Multiplexing Techniques	3.1 Characteristics: Selectivity, Sensitivity & Fidelity. Superheterodyne receiver: Detail block diagram, Need and types of AGC	3	02	06
	3.2 FM Receiver. Comparison of AM, FM receiver.		02	
	3.2 FDM and TDM transmitter & receiver.		02	
4. Fundamentals of Digital Communication	4.1 Digital Communication System: Basic elements of Digital communication system, SNR, Channel capacity, Bit interval and Bit rate, Baud rate, (Numerical on SNR, Channel capacity, Bitrate/Baud rate), Transmission Media: Guided and Unguided, Line Encoding and its types: Digital to digital (Polar and Bipolar techniques with respect to waveform).	4	05	07
	4.2 AWGN, Comparison of different receivers with respect to Probability of Error: Integrate and dump, Optimum Filter, Matched filter, Correlator. ISI, Eye Diagrams.		02	
5. Digital Modulation and Demodulation	5.1 Shannon limit for information capacity, Amplitude Shift Keying (ASK): Modulator, waveform, Baudrate, Frequency Shift Keying (FSK): Transmitter, Receiver and Concept of M-ary FSK, Phase Shift Keying (PSK) BPSK: Generation, Reception, waveform, spectrum and Bandwidth QPSK: Phasor diagram, waveform, Transmitter-Receiver and advantages Quadrature Amplitude Modulation (QAM) 8 QAM: Bandwidth Efficiency.	5	06	07
	5.2 Comparison of various Digital Communication Systems (ASK – FSK – PSK – QAM).		01	
6. Source and Error Control Coding	6.1 Information, mutual information, Entropy. Source encoding theorem: Shannon Fano coding, Huffman coding.	6	03	08
	6.2 Introduction of error control system: Automatic Retransmission Query (ARQ) system, Forward error correction (FEC) system. Comparison between FEC and ARQ.		05	
	6.3 Error Control Coding: linear block codes, cyclic codes, Convolutional codes: State diagram, trellis diagram and Viterbi decoding.			
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization	-	01	01
			Total:	**42**

Books:	
Text Books	1. Kennedy and Davis, "Electronics Communication System", Tata McGraw Hill, Fourth edition. 2. Modern Digital and Analog Communication Systems, Fourth Edition, Lathi BP and Ding Z, Oxford University Press, 2009 3. Digital Communication System, Fourth Edition, Haykin Simon John Wiley and Sons, New Delhi 2014 4. Digital Communications, Fourth Edition, John G. Proakis, McGraw-Hill
Reference Books	1. Taub, Schilling and Saha, "Taub's Principles of Communication systems", Tata McGraw Hill, Third edition. 2. P. Singh and S.D. Sapre, "Communication Systems: Analog and Digital", Tata McGraw Hill, Third edition 3. Sklar B, and Ray P. K. Pearson, Dorling Kindersley (India), Delhi, 2009 4. Analog and Digital Communication, First Edition, T L Singal, Tata McGraw Hill, New Delhi, 2012 5. Digital Communication, First Edition, P Ramakrishna Rao, Tata Mc-Graw Hill, New Delhi, 2011
Useful Links:	1. Course: Analog Communication by Prof. Goutam Das (IIT Kharagpur); https://swayam.gov.in/nd1_noc20_ee69/preview 2. https://nptel.ac.in/courses/106/103/106103068/1 3. https://nptel.ac.in/courses/117/101/117101051/ 4. https://nptel.ac.in/courses/117/105/117105077/ 5. https://nptel.ac.in/courses/108/101/108101113/ 6. https://nptel.ac.in/courses/108/102/108102096/ 7. https://nptel.ac.in/courses/108/102/108102120/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Course Name	Credits (TH+P+TUT)
EXC403	**Microcontrollers**	**3+0+0**
Prerequisite:	Digital System Design	
Course Objectives:	1. To develop background knowledge of Computers and its memory System. 2. To understand the architecture of 8051 and ARM7 core. 3. To write programs for 8051 microcontrollers. 4. To understand the design of Microcontroller and ARM Applications.	
Course Outcomes:	1. Outline Microcomputer system and various microcomputers architecture model 2. Outline Memory System concept of microcomputer 3. Outline the detailed architecture of 8051. 4. Write programs for 8051 microcontrollers and Interface various peripheral devices to the microcontrollers. 5. Outline the detailed architecture of ARM7 Core. 6. Write Assembly language and Embedded C program for microcontrollers.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02
1. Overview of Microcomputer based System	1.1 Overview of microcomputer systems and their building blocks, Memory	1	01	05
	1.2 Interfacing, Steps taken by the microprocessor to fetch and executes an instruction from the memory		01	
	1.3 Concepts of Program counter register, Reset, Stack and stack pointer , Subroutine, Interrupts and Direct Memory Access		01	
	1.4 Concept of RISC & CISC Architecture		01	
	1.5 Harvard & Von Neumann Architecture		01	
	1.6 Comparison between Microprocessor and Microcontroller, Applications of microcontrollers			
2. The Memory Systems	2.1 Classification of Memory : Primary and Secondary	2	01	04
	2.2 Types of Semiconductor memories		01	
	2.3 Cache Memory		01	
	2.4 Virtual Memory Concept with Memory Management Unit with Segmentation and Paging (Address		01	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Translation Mechanism)			
3. 8051 Microcontroller	3.1 Features, architecture and pin configuration	3	02	08
	3.2 CPU timing and machine cycle		01	
	3.3 Input / Output ports		01	
	3.4 Memory organization		01	
	3.5 Counters and timers		01	
	3.6 Interrupts		01	
	3.7 Serial data input and output		01	
4. 8051 Assembly Language Programming and Interfacing	4.1 Addressing modes	4	01	10
	4.2 Instruction set		01	
	4.3 Need of Assembler & Cross Assemble, Assembler Directives		01	
	4.5 Programs related to: arithmetic, logical, delay subroutine , input, output, timer, counters, port, serial communication, and interrupts		04	
	4.6 Interfacing with LEDs, Relay and Keys, LCD and Seven Segment Display		03	
5. ARM7	5.1 Introduction & Features of ARM 7	5	01	08
	5.2 Concept of Cortex-A, Cortex-R and Cortex-M		01	
	5.3 Architectural inheritance, Pipelining		02	
	5.4 Programmer's model		01	
	5.5 Brief introduction to exceptions and interrupts handling		01	
	5.6 Instruction set: Data processing, Data Transfer, Control flow		02	
6. ARM Programming with Embedded C	6.1 General Purpose Input Output	6	01	04
	6.2 Timer Mode		01	
	6.3 Pulse–Width Modulator Configuration		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization	-	01	01
			Total:	**42**

Books:	
Text Books	1. C. Kenneth J. Ayala and D. V. Gadre, "The 8051 Microcontroller & Embedded system using assembly & 'C' ", Cengage Learning, Edition 2010. 2. Douglas V Hall, SSSP Rao "Microprocessors & Interfacing", McGraw Hill 3. M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, "The 8051 Microcontroller & Embedded systems", Pearson Publications, Second Edition 2006. 4. James A. Langbridge, "Professional Embedded Arm Development", Wrox, John Wiley Brand & Sons Inc., Edition 2014 5. Lyla Das, Embedded Systems: An Integrated Approach‖, Pearson Publication, First Edition 2013 6. Steve Furber, "ARM System on chip Architecture", Pearson, 2nd edition. 7. Shibu K. V "Introduction to embedded systems" McGraw Hill.
Reference Books	1. "MCS@51 Microcontroller, Family User's Manual" Intel 2. P89V51RB2/RC2/RD2 8-bit 80C51 5 V low power 16/32/64 kB flash microcontroller, Data Sheet NXP founded by Philips 3. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, "Computer Organization", Fifth Edition, Tata McGraw-Hill
Useful Links:	Course: Microprocessors and Microcontrollers by Prof. Santanu Chattopadhyay (IIT Kharagpur); https://swayam.gov.in/nd1_noc20_ee42/preview

Continuous Assessment(CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Course Name	Credits (TH+P+TUT)
EXC404	**Signals and Systems**	**3+0+0**
Prerequisite:	Applications of Mathematics in Engineering-I	
Course Objectives:	1. To introduce students to the idea of signal and system analysis and characterization in time and frequency domain. 2. To provide foundation of signal and system concepts to areas like communication, control and comprehend applications of signal processing in communication systems.	
Course Outcomes:	1. Describe different types of signals and systems 2. Apply convolution and correlation to continuous time and discrete time systems in time domain 3. Apply Fourier series to continues time and discrete time signals and systems 4. Apply Fourier transform to continues time and discrete time signals and systems 5. Apply Laplace transform to continues time LTI systems 6. Apply Z-transform to continues time LTI systems	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02	02
1. Introduction to signals and systems	1.1 Introduction to Signals: Definition, Basic Elementary signals -exponential, sine, step, impulse, ramp, rectangular, triangular. Operations on signals. Classification of Signals: Analog and discrete time signals, even and odd signals, periodic and non-periodic signals, deterministic and non-deterministic signals, energy and power signals.	1	04	08
	1.2 Systems and Classification of systems: System Representation, continuous time and discrete systems, system with and without memory, causal and non-causal system, linear and nonlinear system, time invariant and time variant system, stable system.		04	
2. Time domain analysis of Continuous	2.1 Linear Time Invariant (LTI) systems: Impulse, step and exponential response, System Stability and Causality.	2	02	10

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
Time and Discrete Time systems	2.2 Use of convolution integral and convolution sum for analysis of LTI systems, properties of convolution integral/sum, impulse response of interconnected systems.		04	
	2.3 Correlation and spectral Density: auto-correlation, cross correlation, analogy between correlation and convolution, energy spectral density, power spectral density, relation of ESD and PSD with auto-correlation.		04	
3. Review of Fourier series	3.1 Trigonometric and exponential Fourier series representation of signals, Gibb's phenomenon, Discrete Time Fourier Series, properties, analogy between Continuous Time Fourier Series (CTFS) and Discrete Time Fourier Series (DTFS).	2, 3	03	03
4. Fourier Analysis of Continuous and Discrete Time Signals and Systems	4.1 Fourier transform of periodic and non-periodic functions, Properties of Fourier Transform (No proof required), Inverse Fourier Transform, Frequency Response: computation of Magnitude and Phase Response, Limitations of Fourier Transform.	3	06	06
5. Laplace Transform and Continuous time LTI systems	5.1 Need of Laplace Transform, Concept of Region of Convergence, Properties of Laplace Transform (No proof required), Relation between continuous time Fourier Transform and Laplace Transform, unilateral Laplace Transform, inverse Laplace Transform.	4	04	06
	5.2 Analysis of continuous time LTI systems using Laplace Transform: Causality and stability of systems in *s*-domain, Total response of a system.		02	
6. Z-Transform and Discrete time LTI systems	6.1 Need of z-Transform, z-Transform of finite and infinite duration sequences, Concept of Region of Convergence, z-Transform properties (No proof required), Standard z-transform pairs, relation between z-transform and discrete time Fourier Transform, one sided Z-Transform. Inverse z-Transform: Partial Fraction method only.	5	03	06
	6.2 Analysis of discrete time LTI systems using z-Transform: Systems characterized by Linear constant coefficient difference equation, Transfer Function, plotting Poles		03	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	and Zeros of a transfer function, causality and stability of systems, Total response of a system.			
ii. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization	-	01	01
			Total:	**42**

Books:	
Text Books	1. Signals and Systems, Third Edition, Nagoor Kani, Tata McGraw Hill, 2011. 2. Signals and Systems, Fourth Edition, Rodger E Ziemer, William H. Tranter and D. Ronald Fannin, Pearson Education,2009. 3. Signals and Systems, Second Edition, Alan V. Oppenhiem, Alan S. Willsky and S. Hamid Nawab, Prentice-Hall of India, 2002. 4. Signals and Systems, Fourth Edition, Ramesh Babu, Scitech
Reference Books	1. Signals and Systems, Third edition, Hwei. P Hsu, Tata McGraw Hill, 2010 2. Signals and Systems, Second Edition, Simon Haykin and Barry Van Veen, John Wiley and Sons, 2004 3. Signals and Systems, First Edition, V. Krishnaveni and A. Rajeshwari Wiley-India, 2012
Useful Links:	1. Course: Principles of Signals & Systems by Prof. Aditya K. Jagannatham (IIT Kanpur); https://swayam.gov.in/nd1_noc20_ee15/preview 2. Signals and Systems Laboratory: Virtual Laboratory http://ssl-iitg.vlabs.ac.in/

Continuous Assessment(CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Course Name	Credits (P+TUT)
EXL402	**Analog and Digital Communication Laboratory**	**1+0**

Lab Prerequisite:	1. Electronic devices and Linear Integrated circuits
Lab Objectives:	1. To demonstrate continuous wave modulation and demodulation. 2. To demonstrate analog and digital pulse communication. 3. To learn source coding and error control coding techniques 4. To compare different line coding methods 5. To distinguish various digital modulations 6. To demonstrate Multiplexing of signal
Lab Outcomes:	1. Analyze analog modulation and demodulation techniques 2. Analyze various source coding schemes and different error control codes. 3. Demonstrate Time Division Multiplexing technique. 4. Demonstrate various digital modulation techniques 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02
1	Generation & Detection of AM/FM signals.	01	02
2	Verification of sampling theorem and generation and detection of PAM.	04	02
3	Generation and detection of PWM and PPM.	04	02
4	Demonstrate Digital pulse transmission technique (PCM)	04	02
5	Demonstrate Digital pulse transmission technique (DM/ADM)	04	02
6	Observation of TDM/FDM multiplexing and de-multiplexing signals.	03	02
7	Observe different data formats: NRZ-L, NRZ-S, RZ-L, RZ-S, AMI	04	02
8	Demonstrate Modulation and Demodulation of ASK/ FSK/ PSK	04	02
9	Demonstrate the effect of signal Distortion using EYE-Diagram	04	02

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
10	Demonstrate of Bit error rate in digital communication	04	02
11	Demonstrate Modulation and Demodulation of Quadrature Phase Shift Keying	04	02
12	Simulate AM/FM/PM using MATLAB	01	02
13	Simulate Pre-emphasis and De-emphasis circuit	04	02
14	Simulate PAM/PWM/PPM using MATLAB	04	02
15	Simulate PCM/DM/ADM using MATLAB	04	02
16	Write program in MATLAB to find Gain, Noise Figure and Noise Temperature of multistage amplifier	01	02
17	Perform Linear Block codes	04	02
18	Simulate QAM using MATLAB	04	02
19	Demonstrate Modulation and Demodulation of Quadrature Phase Shift Keying.	04	02
		Total	**40**

(Minimum 8 experiments should be conducted. Out of eight two experiments should be simulation based.)

References:

[1] Lab manuals [2] www.mathworks.com [3] www.scilab.org [4] www.ni.com/labview

Useful Links:

1. http://ssl-iitg.vlabs.ac.in/Sampling%20and%20signal%20reconstruction%20 (objective).html
2. https://www.vlab.co.in/broad-area-electronics-and-communications

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Assignments/ Case study/ Project/ demo/ presentation: 10-marks)

Oral/Practical/P&O:

Oral & Practical examination will be based on the experiment list and content of the entire theory syllabus and carries 25 Marks

Course Code	Course Name	Credits (P+TUT)
EXL403	**Microcontrollers Laboratory**	**1+0**
Lab Prerequisite:	Digital System Design	
Lab Objectives:	1. To understand development tools of microcontroller based systems. 2. To learn programming for different microcontroller operation & interface to I/O devices. 3. To develop microcontroller based applications.	
Lab Outcomes:	1. Outline different development tools required to develop microcontroller based systems 2. Write assembly language programs for arithmetic and logical operations, code conversion & data transfer operations for 8051 and ARM7 3. Write assembly language programs for general purpose I/O, Timers & Interrupts. 4. Programs for 8051 microcontrollers and Interface various peripheral devices to the microcontrollers and develop microcontroller based applications 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory	

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02
1	Study of development tools like Editor, Assembler-cross Assembler, Compiler-Cross compiler, Linker, Simulator, emulator etc.	1, 5, 6	02
2	Perform Arithmetic and Logical Operations (Using Immediate, Direct and Indirect addressing) 8051 and ARM 7	2, 5, 6	02
3	Code Conversion	2, 5, 6	02
4	Transfer of data bytes between Internal and External Memory	2, 5, 6	02
5	Experiments based on General Purpose Input-Output, Timers, Interrupts, Delay for 8051	3, 5, 6	02
6	Interfacing of Matrix Keyboard, LED, 7 Segment display, LCD, Stepper Motor, UART	4, 5, 6	02
7	Perform Arithmetic (Using Immediate, Direct and Indirect addressing) ARM 7	2, 5, 6	02
8	Perform Logical Operations (Using Immediate, Direct and Indirect addressing) ARM 7	2, 5, 6	02
9	Case Study/ Mini Project	1 to 6	10
		Total	**28**

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Assignments/Case study/ Project/ demo/ presentation: 10-marks)

Oral/Practical/P&O:

Practical examination will be based on the experiment list and content of the entire theory syllabus carries 25 Marks

Project Based Learning Code	Project Based Learning	Credits (TH+P+TUT)
EXPR42	**Community Engagement PBL – Mini Project II (Raspberry Pi based projects)**	**0+1+0**

Objectives	
1	To acquaint yourself with the process of identifying the needs and converting it into the problem.
2	To familiarize the process of solving the problem in a group.
3	To acquaint yourself with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4	To inculcate the process of self-learning and research.
Outcome: Learner will be able to…	
1	Identify problems based on societal /research needs.
2	Apply Knowledge and skill to solve societal problems in a group.
3	Develop interpersonal skills to work as member of a group or leader.
4	Draw the proper inference from available results through theoretical/ experimental/simulations
5	Analyze the impact of solutions in societal and environmental context for sustainable development.
6	Use standard norms of engineering practices
7	Excel in written and oral communication.
8	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9	Demonstrate project management principles during project work.
Guidelines for Mini Project	
1	Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
2	Students should do surveys and identify needs, which shall be converted into problem statements for mini projects in consultation with faculty supervisor/internal committee of faculties.
3	Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini projects.
4	A logbook to be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.
5	Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
6	Students in a group shall understand problems effectively, propose multiple solutions and select the best possible solution in consultation with the guide/ supervisor.
7	Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
8	The solution to be validated with proper justification and report to be compiled in standard format of the college.

9	With the focus on self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV.
10	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or completely new project ideas in even semester. This policy can be adopted on a case-by-case basis. **Note: Project Should More Towards Societal Based And Health Care Based.**

Term Work:		
The review/ progress monitoring committee shall be constituted by senior faculty members. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester. Assessment also considers peer review and ethics observed by faculties and participation involvement.		
In continuous assessment focus shall also be on each individual student, log book maintained and weekly meeting based on the same.		
Distribution of Term work marks for both semesters shall be as below:		**Practical Marks**
1	Marks awarded by guide/supervisor based on implementation	10
2	Peer assessment by team members	05
3	Marks awarded by review committee	05
4	Quality of Project report	05
Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines		
One-year project:		
1	In the first semester the entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on the presentation given by the student group. ● First shall be for finalization of problem ● Second shall be on finalization of the proposed solution of the problem.	
2	In the second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. ● First review is based on readiness of building working prototypes to be conducted. ● Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.	
Half-year project:		
1	In this case in one semester students' group shall complete project in all aspects including, ● Identification of need/problem ● Proposed final solution ● Procurement of components/systems ● Building prototype and testing	

2	Continuous assessment will be weekly based on a logbook. Two presentations will be conducted for review before a panel. • First shall be for finalization of problem and proposed solution • Second shall be for implementation and testing of solutions.
Assessment criteria of Mini Project:	
Mini Project shall be assessed based on following criteria;	
1	Quality of survey/ need identification
2	Clarity of Problem definition based on need.
3	Innovativeness in solutions
4	Feasibility of proposed problem solutions and selection of best solution
5	Cost effectiveness
6	Societal impact
7	Innovativeness
8	Cost effectiveness and Societal impact
9	Full functioning of working model as per stated requirements
10	Effective use of skill sets
11	Effective use of standard engineering norms
12	Contribution of an individuals as member or leader
13	Clarity in written and oral communication
In **one year, project**, first semester evaluation may be based on the first six criteria and the remaining may be used for the second semester evaluation of performance of students in the mini project.	
In the case of a half **year project** all criteria's in generic may be considered for evaluation of performance of students in a mini project.	
Guidelines for Assessment of Mini Project Practical/Oral Examination:	
1	Report should be prepared as per the guidelines issued by the University of Mumbai.
2	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
3	Students shall be motivated to participate in poster, project competition on the work in students' competitions.
Mini Project shall be assessed based on following points;	
1	Quality of problem and Clarity
2	Innovativeness in solutions
3	Cost effectiveness and Societal impact
4	Full functioning of working model as per stated requirements
5	Effective use of skill sets
6	Effective use of standard engineering norms
7	Contribution of an individuals as member or leader
8	Clarity in written and oral communication

Project Based Learning Code	Project Based Learning Course Name	Credits (P+TUT)
EXPR42	**Community Engagement PBL – Mini Project II**	**0+1+0**
PBL Prerequisite:	1. Mini-Project 1- PBL 2. C++ and Java Programming 3. Electronic Devices and Circuit	
PBL Objectives:	1. Become familiar with Raspberry Pi (Rpi) hardware. 2. Setup and Install Raspbian OS on Rpi. 3. Understand how Rpi can be leveraged as an IoT gateway. 4. Become familiar with Linux OS. 5. Setup Rpi as an IoT gateway. 6. Using Python Interface with Arduino using Serial Port Interface.	
PBL Outcomes (PROs):	After successful completion of the course student will be able to: 1. Wire Raspberry Pi and create a fully functional computer. 2. Use Python-based IDE and trace and debug Python code on the device. 3. Measure physical parameter using sensors. 4. Implement various communication protocols for wired and wireless communication. 5. Interfaces different motors and create robots.	

Experiment No.	Unit No.	Raspberry – Pi	Hrs.	PRO Mapped
EX.1.0		**Introduction to Raspberry Pi**	**02**	**3**
	1.1	What is Raspberry PI? Downloading and Installation of NOOBS, First Power- Up & Having a Look around, Introduction to the Shell and Staying updated.		
	1	Familiarization with Raspberry PI and perform necessary software installation.		
	2	Apparatus Requirement: Hardware: Raspberry PI Board, Memory of 16GB, Power adapter, Memory Writer.		
	3	Software: NOOBS, Raspbian OS, Win32 disk Imager, SD-Formatter software.		
EX.2.0		**Interfacing with Input / Output Devices using Python**	**04**	**3**
	2.1	Introduction to Python, Connecting to the outside World with GPIO.		
	1	To Interface LED/Buzzer with Raspberry PI and write a program to turn ON LED for 1 sec after every 2 sec. Apparatus Requirement: Raspberry PI with inbuilt Python Package, LED, Buzzer.		
	2	To interface Push Button / Digital Sensor (IR/LDR) with Raspberry PI and write a program to turn ON LED when Push button is pressed or at sensor detection. Apparatus Requirement: Raspberry PI with inbuilt Python Package, Push Button Switch, Digital Sensor (IR/LDR).		
	3	To interface analog sensor using MCP 3008 analog to digital converter chip. Apparatus Requirement: Raspberry PI with inbuilt Python Package, analog sensor, MCP 3008 chip.		

Experiment No.	Unit No.	Raspberry – Pi	Hrs.	PRO Mapped
EX.3.0		**Interfacing Temperature Sensor, Motors, Display Devices.**	**04**	**4**
	3.1	Introduction to Temperature sensor (Analog and Digital), Relays, Motors (DC, Stepper) and Driver circuits.		
	1	To interface DHT11 sensor with Raspberry PI and write a program to print temperature and humidity readings. Apparatus Requirement: Raspberry PI with inbuilt Python Package, DTH11 Sensor.		
	2	To interface motor using relay with Raspberry PI and write a program to turn ON motor when push button is pressed. Apparatus Requirement: Raspberry PI with inbuilt Python Package, Relays, Motor Driver, Motors.		
	3	To interface OLED with Raspberry PI and write a program to print temperature and humidity readings on it. Apparatus Requirement: Raspberry PI with inbuilt Python Package, OLED display device.		
EX.4.0		**Interfacing Communication Devices and Cloud Networking**	**04**	**5**
	4.1	Introduction to Bluetooth, Zigbee, RFID and WIFI, specifications and interfacing methods.		
	1	To interface Bluetooth/Zigbee/RFID/WiFI with Raspberry PI and write a program to send sensor data to smartphone using Bluetooth/Zigbee/RFID/WIFI. (Any one can be used for performing) Apparatus Requirement: Raspberry PI with inbuilt Python Package, Bluetooth/Zigbee/RFID/WIFI.		
	2	Introduction to Cloud computing, different types cloud networks and interconnection using Raspberry PI		
	3	Write a program on Raspberry PI to upload temperature and humidity data from thing speak cloud. Apparatus Requirement: Raspberry PI with inbuilt Python Package, Cloud networks such as thing speak (open source), AWS, Azure, etc. anyone can be used for understanding purpose and building projects.		
EX.5.0		**Understanding of Communication Protocols**	**04**	**6**
	5.1	Introduction to MQTT, IFTTT protocols and configuration steps.		
	1	Write a program on Raspberry PI to publish temperature data to MQTT broker		
	2	Write a program on Raspberry Pi to subscribe to MQTT broker for temperature data and print it.		
	3	Configuration of Webserver using Raspberry PI.		
EX.6.0		**Sample Projects**	**10**	**6**
	1.	MQTT Based Raspberry Pi Home Automation: Controlling Raspberry Pi GPIO using MQTT Cloud		
	2.	License Plate Recognition using Raspberry Pi and OpenCV		
	3.	Real Time Face Recognition with Raspberry Pi and OpenCV		
	4.	Smart Garage Door Opener using Raspberry Pi		
	5.	Remote Controlled Car Using Raspberry Pi and Bluetooth		
	6.	Fingerprint Sensor based door locking system using Raspberry Pi		
	7.	Raspberry Pi Ball Tracking Robot using Processing		
	8.	Web Controlled Home Automation using Raspberry Pi		

Experiment No.	Unit No.	Raspberry – Pi	Hrs.	PRO Mapped
	9.	Line Follower Robot using Raspberry Pi		
	10.	Raspberry Pi based Smart Phone Controlled Home Automation		
	11.	Web Controlled Raspberry Pi Surveillance Robotic Car		
	12.	Raspberry Pi Based Weight Sensing Automatic Gate		
	13.	Raspberry Pi Emergency Light with Darkness and AC Power Line Off Detector		
	14.	Detecting Colors using Raspberry Pi and Color Sensor TCS3200		
	15.	Measure Distance using Raspberry Pi and HCSR04 Ultrasonic Sensor		
	16.	Call and Text using Raspberry Pi and GSM Module		
	17.	Raspberry Pi Home Security System with Email Alert		
	18.	Raspberry Pi Based Obstacle Avoiding Robot using Ultrasonic Sensor		
	19.	Web Controlled Notice Board using Raspberry Pi		
	20.	RF Remote Controlled LEDs Using Raspberry Pi		
	21.	RFID and Raspberry Pi Based Attendance System		
	22.	Raspberry Pi Interactive Led-Mirror		
	23.	Garage Door monitor using Raspberry Pi		
	24.	Raspberry Pi Digital Code Lock on Breadboard		
	25.	Electronic Voting Machine using Raspberry Pi		
		Total	**28**	
*** Preferably the Project should be based on Arduino Boards**				

Reference Books:	1. Simon Monk, "Hacking Electronic: Learning Arduino and Raspberry Pi", McGraw-Hill Education TAB; 2nd edition (September 28, 2017) 2. Simon Monk, "Raspberry PI Cookbook Software and Hardware Problems and Solutions" O'Reilly 2nd Edition 3. Simon Monk, Programming the Raspberry Pi, 2nd Edition: Getting Started with Python" The McGraw Hill 4. "DK Workbooks: Raspberry Pi Project Workbook", DK Children; Workbook edition (March 7, 2017) 5. Donald Norris, "Raspberry Pi Electronic Projects for Evil Genius", McGraw-Hill Education TAB; 1 edition (May 20, 2016)
Useful Links:	**Software Tools:** • Raspbian OS: https://www.raspberrypi.org/downloads/ • Win32 Disk Imager: https://sourceforge.net/projects/win32diskimager/ • SD Card Formatter: https://www.sdcard.org/downloads/formatter/ • Arduino IDE: https://www.arduino.cc/en/main/software
Online Repository:	1. GitHub 2. NPTEL Videos on Raspberry Pi and Arduino Programming 3. https://www.electronicsforu.com/raspberry-pi-projects 4. https://circuitdigest.com/simple-raspberry-pi-projects-for-beginners 5. https://www.electronicshub.org/raspberry-pi-projects/ 6. Spoken Tutorial Project-IIT Bombay: https://spoken-tutorial.org/tutorialsearch/?searchFoss=Arduino&search_language=English Teachers are recommended to use a free online simulation platform "Tinker cad" for the simulation of Arduino based circuits before the students implement it in the hardware: ht://www.tinkercad.com/

Note: General Guidelines and assessment criteria will remain same as Mini project-I

Skill Based Learning Code	Skill Enhancement – SAT VIII: Skill-Based Learning	Credits (TH+P+TUT)
EXXS48	**Python Programming**	**0+1+0**
Skill Prerequisite:	1. Knowledge of some programming language like C++ 2. Knowledge of some programming language like Java	
Skill Objectives:	1. To study List, tuple, set, dictionary, string, array and functions in python programming language. 2. To study List, tuple, set, dictionary, string, array and functions in python programming language. 3. To study data structures and Object-Oriented Programming using Python. 4. To explain concepts of modules, packages and exception handling. 5. To study File handling, django framework and regular expression. 6. To study data visualization using Matplotlib, data analysis using Pandas and Web programming using Flask.	
Skill Outcomes:	1. Apply the structure, syntax, and semantics of the Python language. 2. Implement the concept of advanced data types and functions in python 3. Illustrate data structures the concepts of object-oriented programming as used in Python 4. Create Python applications using modules, packages, exception handling, File Handling programs, Matplotlib, data analysis using Pandas and Web programming using Flask. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.	

Module No	Module Title	SO Mapped	Hrs/ Module
i. Prerequisites and Course Outline	Prerequisite Concepts and Course Introduction.	-	02
1	Write python programs to understand 1.1 Basic data types, Operators, expressions and Input Output Statements 1.2 Control flow statements: Conditional statements (if, if…else, nested if) 1.3 Looping in Python (while loop, for loop, nested loops) 1.4 Decorators, Iterators and Generators. Concepts: 1.1 Introduction, Features, Python building blocks – Identifiers, Keywords, Indention, Variables and Comments. 1.2 Basic data types (Numeric, Boolean, Compound) Operators: Arithmetic, comparison, relational,	1, 5, 6	04

Module No	Module Title	SO Mapped	Hrs/ Module
	assignment, logical, bitwise, membership, identity operators and operator precedence. 1.3 Control flow statements: Conditional statements (if, if…else, nested if) Looping in Python (while loop, for loop, nested loops) Loop manipulation using continue, pass, break. Input/output Functions, Decorators, Iterators and Generators.		
2	Write python programs to understand 2.1 Different List and Tuple operations using Built-in functions 2.2 Built-in Set and String functions 2.3 Basic Array operations on 1-D and Multidimensional arrays using Numpy 2.4 Implementing User defined and Anonymous Functions Concepts: 2.1 Lists: a) Defining lists, accessing values in list, deleting values in list, updating lists b) Basic list operations c) Built-in list functions 2.2 Tuples: a) Accessing values in Tuples, deleting values in Tuples, and updating Tuples b) Basic Tuple operations c) Built-in Tuple functions 2.3 Dictionaries: a) Accessing values in Dictionary, deleting values in Dictionary, and updating Dictionary b) Basic Dictionary operations c) Built-in Dictionary functions 2.4 Sets: a) Accessing values in Set, deleting values in Set, updating Sets b) Basic Set operations, c) Built-in Set functions 2.5 Strings: a) String initialization, Indexing, Slicing, Concatenation, Membership & Immutability b) Built-in String functions 2.6 Arrays: a) Working with Single dimensional Arrays: Creating, importing, Indexing, Slicing, copying and processing array arrays. b) Working with Multi-dimensional Arrays using Numpy: Mathematical operations, Matrix operations, aggregate and other Built-in functions. 2.7 Functions: a) Built -in functions in python b) Defining function, calling function, returning values, passing parameters c) Nested and Recursive functions d) Anonymous Functions (Lambda, Map, Reduce, Filter.	2, 5, 6	06
3	Write python programs to understand 3.1 Classes, Objects, Constructors, Inner class and Static method 3.2 Different types of Inheritance	3, 5, 6	03

Module No	Module Title	SO Mapped	Hrs/ Module
	3.3 Polymorphism using Operator overloading, Method overloading, Method overriding, Abstract class, Abstract method and Interfaces in Python. Concepts: 3.1 Overview of Object-oriented programming, Creating Classes and Objects, Self-Variable, Constructors, Inner class, Static method, Namespaces. 3.2 Inheritance: Types of Inheritance (Single, Multiple, Multi-level, Hierarchical), Super() method, Constructors in inheritance, operator overloading, Method overloading, Method overriding, Abstract class, Abstract method, Interfaces in Python		
4	Write python programs to understand 4.1 Creating User-defined modules/packages and import them in a program 4.2 Creating user defined multithreaded application with thread synchronization and deadlocks 4.3 Creating a menu driven application which should cover all the built-in exceptions in python Concepts: 4.1 Modules: Writing modules, importing objects from modules, Python built -in modules (e.g. Numeric and Mathematical module, Functional Programming module, Regular Expression module), Namespace and Scoping. 4.2 Packages: creating user defined packages and importing packages. Exception handling: Compile time errors, Runtime errors, exceptions, types of exception, try statement, except block, raise statement, Assert statement, User -Defined Exceptions 4.3 Creating a menu driven application which should cover all the built-in exceptions in python	4, 5, 6	03
5	Write python programs to implement 5.1 Different types of plots using Matplotlob 5.2 Basic operations using pandas like series, data frames, indexing, filtering, combining and merging data frames 5.3 Different Linear algebra functions using Scipy Concepts: 5.1 Visualization using Matplotlib: Matplotlib with Numpy, working with plots (line plot, bar graph, histogram, scatter plot, area plot, pie chart etc.), working with multiple figures. 5.2 Data manipulation and analysis using Pandas: Introduction to Pandas, importing data into Python,	4, 5, 6	05

Module No	Module Title	SO Mapped	Hrs/ Module
	series, data frames, indexing data frames, basic operations with data frame, filtering, combining and merging data frames, Removing Duplicates. SciPy: Linear algebra functions using Numpy and Scipy.		
6	Write python programs to understand 6.1 Different File Handling operations in Python 6.2 Creating web application using flask web framework to demonstrate functionality of user login and registration (also validating user detail using regular expression) 6.3 Server side deployment of flask applications: - mod wsgi Concepts: 6.1 File Handling: Opening file in different modes, closing a file, writing to a file, accessing file contents using standard library functions, reading from a file – read (), readline (), readlines (), Renaming and Deleting a file, File Exceptions, Pickle in Python. 6.2 Flask framework and Regular Expressions using python	4, 5, 6	05

Books:	
Text Books	1. Dr. R. Nageswara Rao, "Core Python Programming", Dreamtech Press 2. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox Publication 3. Anurag Gupta, G. P. Biswas, "Python Programming", McGraw-Hill 4. E. Balagurusamy, "Introduction to computing and problem-solving using python", McGraw Hill Education
Reference Books	1. Eric Matthes, "Python Crash Course A hands-on, Project Based Introduction to programming" No Starch Press; 1 edition (8 December 2015). 2. Paul Barry, "Head First Python" O′Reilly; 2 editions (16 December 2016) 3. Online resources for Flask

Useful Links:

1. https://python-iitk.vlabs.ac.in/
2. http://vlabs.iitb.ac.in/vlabs-dev/labs/python-basics/index.html
3. www.nptelvideos.in
4. www.w3schools.com
5. www.tutorialspoint.com
6. https://starcertification.org/Certifications/Certificate/securejava

Term Work (25 Marks):
Term Work shall be awarded on the basis of 1. Student's active participation in skill based learning. 2. Presenting/showcasing learned skills through Social /outreach/ extension activities/Events/ Competitions/Trainings/Internships etc. 3. Submission of Report/act/demonstrations/specific participation / Idea creation / scope / creativity / Case study etc. 4. Assessment Rubrics.

Skill Based Learning Code	Ability Enhancement – SAT IX: Skill-Based Learning	Credits (TH+P+TUT)
EXXS49	**(Foreign and Indian Modern Languages-II)**	**0+1+0**
SBL Objectives (SOBs):	1. Acquire reading and writing proficiency in the target language 2. Understand the common heritage of, and diversity among, countries that speak the target language. 3. Communicate and interact effectively with citizens of the target cultures.	
SBL Outcomes (SOs):	Upon completion of the course, the learners will be able to: 1. Demonstrate of communicative proficiency in the target language. 2. Write the target language in formal expository prose that impede communication. 3. Learn through MOOC online courses to adopt hybrid mode of learning	
Guidelines for Skill-Based Learning (SBL):	Each student has to complete any one Foreign and/or Indian Language MOOC course from NPTEL/Coursera/Udemy etc. sites referring the suggestive given list of course but are not limited to the list as it's a learner's choice for the interested course in the given semester time frame.	

Sr. No.	Suggestive list of Courses
1	Introduction to Japanese Language and Culture
2	German – II & III
3	The Psychology of Language
4	Spanish Vocabulary: Meeting People , Cultural Experience, Sports, Travel, and the Home, Careers and Social Events, Spanish Vocabulary Project
5	A Bridge to the World: Korean Language for Beginners, First Step Korean, Learn to Speak Korean 1, The Korean Alphabet: An Introduction to Hangeul
6	Complete French Course: Learn French for Beginners
7	Complete German Course: Learn German for Beginners
8	Spanish 1-4: Beginner, Elementary, Intermediate and Advanced
9	Complete Japanese Course: Learn Japanese for Beginners
10	Complete Korean Course: Learn Korean for Beginners
11	The Complete Russian Language Course
12	Spoken Sanskrit: Basic and Intermediate Levels
13	Applied Linguistics
14	Fundamental Concepts in Sociolinguistics
15	Introduction to Basic Spoken Sanskrit and intermediate level to Basic Spoken Sanskrit

Online Resources:

Sr. No.	Suggestive Course Link but are not limited to following recourses only
1	https://onlinecourses.nptel.ac.in/noc22_hs84/preview
2	https://onlinecourses.nptel.ac.in/noc22_hs89/preview
3	https://onlinecourses.nptel.ac.in/noc22_hs123/preview
4	https://www.coursera.org/learn/spanish-vocabulary-meeting-people https://www.coursera.org/learn/spanish-vocabulary-cultural-experience https://www.coursera.org/learn/spanish-vocabulary-sports-travel-home https://www.coursera.org/learn/spanish-vocabulary-careers https://www.coursera.org/learn/spanish-vocabulary-project
5	https://www.coursera.org/learn/korean-beginners https://www.coursera.org/learn/learn-korean https://www.coursera.org/learn/learn-speak-korean1 https://www.coursera.org/learn/the-korean-alphabet-an-introduction-to-hangeul
6	https://www.udemy.com/course/complete-french-course/
7	https://www.udemy.com/course/complete-german-course-learn-german-for-beginners/
8	https://www.udemy.com/course/spanish-101-beginning-spanish-spanish-for-beginners/
9	https://www.udemy.com/course/complete-japanese-course-learn-japanese-for-beginners-lvl-1/
10	https://www.udemy.com/course/complete-korean-course-learn-korean-for-beginners-level-1/
11	https://www.udemy.com/course/the-complete-russian-language-course/
12	https://onlinecourses.nptel.ac.in/noc22_hs114/preview
13	https://onlinecourses.nptel.ac.in/noc22_hs85/preview
14	https://onlinecourses.nptel.ac.in/noc22_hs139/preview

Term Work (25 Marks):
Marks will be awarded based on designed Assessment Rubrics