Dr. Babasaheb Ambedkar Technological University, Lonere

Dr. Babasaheb Ambedkar Technological University
(Established as a University of Technology in the State of Maharashtra)
(Under Maharashtra Act No. XXIX of 2014)
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Course Structure and Detailed Syllabus

of

B. Tech Programme

for

Electronics & Computer Engineering / Electronics and Computer Science

for

Third Year Engineering

In line with National Education Policy 2020

(Effective from Academic year 2026-27 for Affiliated Colleges only)

Department of Electronics and Computer Engineering / Department of Electronics and Computer Science

Credit Framework under Four-Years UG Engineering Programme with Multiple Entry and Multiple Exit options:

- The Four-year Bachelor's Multidisciplinary Engineering Degree Programme allows the students to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per their choices and the feasibility of exploring learning from different institutions.
- The minimum and maximum credit structure for different levels under the Four-year Bachelor's Multidisciplinary Engineering UG Programme with multiple entry and multiple exit options are as given below:

Credit Framework

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
4.5	One Year UG Certificate in Engg./ Tech.	40	44	2	1
5.0	Two Years UG Diploma in Engg./ Tech.	80	88	4	2
5.5	Three Years Bachelor's Degree in Vocation (B. Voc.) or B. Sc. (Engg./ Tech.)	120	132	6	3
	4-Years Bachelor's degree				

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
6.0	(B.E./ B.Tech. or Equivalent) in Engg./ Tech. with Multidisciplinary Minor	160	176	8	4
6.0	4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech.- Honors and Multidisciplinary Minor	180	194	8	4
6.0	4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech.- Honors with Research and Multidisciplinary Minor	180	194	8	4
6.0	4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech.- Major Engg. Discipline with Double Minors (Multidisciplinary and Specialization Minors)	180	194	8	4

- There are multiple exit options at each level. Student will be given a specific Qualification mentioned in the table depending on the level at which he/she decide to have an exit. Ex. If a student decides to exit after completion of two years (level 5.0) of the program, he will be given a Diploma in Engineering with specific exit condition mentioned in the syllabus of the specific branch. He/she can re-join the program with the multiple entry option at the level next where he/she chose to exit previously. (Student can join at level 5.5 if successfully completed level 5.0 previously at the time of exit).
- Minimum credit requirements of each level are mentioned in the credit framework table.
- There are 4 distinct options available at level 6.0.
- First one is basic level 6.0 option where minimum 160-maximum 176 credits are mandatory which can be completed as per the Semester-wise Credit distribution structure mentioned in the table given below.

Here, the Bachelor's Engineering Degree in chosen Engg./ Tech. Discipline with multidisciplinary minor (min.160-max.176 Credits) i.e. "**B. Tech in Electronics and Computer Engineering with Data Science**" (160-176 credits) enables students to take up five-six or required additional courses of 14 credits in the discipline other than Electronics and Computer Engineering distributed over semesters III to VIII. Here in the case of "**B. Tech in Electronics and Computer Engineering with Data Science**" (160-176 credits) student is supposed to complete the assigned 14 credits from other discipline's minor buckets.

- Remaining three level 6.0 options are the advanced options where the student is given an opportunity to get extra qualification by earning some extra credits (18-20 extra credits). These three options are given below:
- Level 6.0: The **Bachelor's Engineering Degree with Honours** in chosen Major Engg./ Tech. Discipline i.e. in Electronics and Computer Engineering with Honours with Multidisciplinary Minor (180-194 credits) enables students of Electronics and Computer Engineering to take up five-six additional courses of 18 to 20 credits in the Electronics and Computer Engineering discipline distributed over semesters III to VIII. The decision regarding the mechanism of distribution of these 18-20 credits over semesters III to VIII, which are over and above the min.160-max.176 Credits prescribed for the duration of four years will be taken by Academic Authorities of University. **Student must have CGPA equal to or greater than 7.5 at the end of second semester to go for this option**.
- Level 6.0: The **Bachelor's Engineering Degree with Research** in i.e. in Electronics and Computer Engineering with Research with Multidisciplinary Minor (180-194 credits) enables students of Electronics and Computer Engineering to take up a research project of 18 to 20 credits in the Electronics and Computer Engineering discipline distributed over semesters VII to VIII. **Student must have CGPA equal to or greater than 7.5 at the end of sixth semester to go for this option**.
- Level 6.0: The **Bachelor's Engineering Degree in chosen Engg./ Tech. Discipline with Double Minor** (Multidisciplinary and Specialization Minor, 180-194 credits), i.e. "**B. Tech in Electronics and Computer Engineering with *other selected discipline in* Engineering (as MDM) with Specialization Minor in Data Science**" (180-194 credits) enables students to take up five-six additional courses of 14 credits in the discipline other than Electronics and Computer Engineering(for completion of multidisciplinary minor) and 18 to 20 extra credits in the **Data Science discipline** distributed over semesters III to VIII. Here, the ***other selected discipline* in Engineering should be different from Specialization Minor i.e. Data Science**. This enables students to take up five-six or required additional courses of 18 to 20 credits in the **Data Science** discipline distributed over semesters III to VIII, which are over and above the min.160-max.176 Credits. The decision regarding the mechanism of distribution of these 18-20 credits over semesters III to VIII, prescribed for the duration of four years will be taken by Academic Authorities of University. **Student must have CGPA equal to or greater than 7.5 at the end of second semester to go for this option**.

Semester-wise Credit distribution structure for Four Year UG Engineering Program - One Major, One Minor

Semester		I	II	III	IV	V	VI	VII	VIII	Total Credits
Basic Science Course	BSC/ESC	06-08	08-10		--	--	--	--	--	14-18
Engineering Science Course		10-08	06-04		--	--	--	--	--	16-12
Programme Core Course (PCC)	Program Courses	--	02	08-10	08-10	10-12	08-10	04-06	04-06	44-56
Programme Elective Course (PEC)		--	--	--	--	04	08	02	06	20
Multidisciplinary Minor (MD M)	Multidisciplinary Courses		-	02	02	04	02	02	02	14
Open Elective (OE) Other than a particular program		--	--	04	02	02	--	--	--	08
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	02	02	--	02	--	02	--	--	08
Ability Enhancement Course (AEC -01, AEC-02)	Humanities Social Science and Management (HSSM)	02	--	--	02	--	--	--	--	04
Entrepreneurship/Economics/ Management Courses		--		02	02	--	--	--	--	04
Indian Knowledge System (IKS)			02		--	--	--	--	--	02
Value Education Course (VEC)		--	--	02	02	--	--	--	--	04
Research Methodology	Experiential Learning Courses	--	--	--	--	--	--		04	04
Comm. Engg. Project (CEP)/Field Project (FP)		--	--	02	--	--	--	-	-	02
Project		--	--	--	--	--	--		04	04
Internship/ OJT		--	---			--	--	12	-	12
Co-curricular Courses (CC)	Liberal Learning Courses	02	02		--	--	--	--	-	04
Total Credits (Major)		**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**160-176**

Student need to follow the Semester-wise Credit distribution structure for Four Year UG Engineering Program as prescribed in the table given above.

- There are seven vertical categories with specific credits distributed in specific semesters.
- Student can choose a Program Elective Course (PEC) in that specific semester from the given subjects.
- Multidisciplinary course (MDM) and Open Elective (OE) courses can be chosen from the MDM and OE Buckets depending on students' choice. Completion of total credits given in the last column of the table for each vertical is mandatory.
- Students can complete 40% of the courses through online platforms like NPTEL/SWAYAM. The NPTEL SWAYAM course content should be at least 80% similar to the course content in the syllabus.

General Rules and Regulations

1. The normal duration of the course leading to B.Tech degree will be EIGHT semesters.
2. The normal duration of the course leading to M.Tech. degree will be FOUR semesters.
3. Each academic year shall be divided into 2 semesters, each of 20 weeks duration, including evaluation and grade finalization, etc. The Academic Session in each semester shall provide for at least 90 Teaching Days, with at least 40 hours of teaching contact periods in a five to six days session per week. The semester that is typically from Mid-July to November is called the ODD SEMESTER, and the one that is from January to Mid-May is called the EVEN SEMESTER. Academic Session may be scheduled for the Summer Session / Semester as well. For 1st year
4. B. Tech and M. Tech the schedule will be decided as per the admission schedule declared by Government of Maharashtra.
5. The schedule of academic activities for a Semester, including the dates of registration, mid-semester examination, end-semester examination, inter-semester vacation, etc. shall be referred to as the Academic Calendar of the Semester, which shall be prepared by the Dean (Academic), and announced at least TWO weeks before the Closing Date of the previous Semester.
6. The Academic Calendar must be strictly adhered to, and all other activities including co-curricular and/or extra -curricular activities must be scheduled so as not to interfere with the Curricular Activities as stipulated in the Academic Calendar.

Registration:

1. Lower and Upper Limits for Course Credits Registered in a Semester, by a Full- Time Student of a UG/PG Programme: A full time student of a particular UG/PG programme shall register for the appropriate number of course credits in each semester/session that is within the minimum and maximum limits specific to that UG/PG programme as stipulated in the specific Regulations pertaining to that UG/PG programme.
2. Mandatory Pre-Registration for higher semesters: In order to facilitate proper planning of the academic activities of a semester, it is essential for the every institute to inform to Dean (Academics) and COE regarding details of total no. of electives offered (Course-wise) along with the number of students opted for the same. This information should be submitted within two weeks from the date of commencement of the semester as per academic calendar.
3. PhD students can register for any of PG/PhD courses and the corresponding rules of evaluation will apply.
4. Under Graduate students may be permitted to register for a few selected Post Graduate courses, in exceptionally rare circumstances, only if the DUGC/DPGC is convinced of the level of the academic achievement and the potential in a student.

Course Pre-Requisites:

1. In order to register for some courses, it may be required either to have exposure in, or to have completed satisfactorily, or to have prior earned credits in, some specified courses.
2. Students who do not register on the day announced for the purpose may be permitted LATE REGISTRATION up to the notified day in academic calendar on payment of late fee.
3. REGISTRATION IN ABSENTIA will be allowed only in exceptional cases with the approval of the Dean (Academic) / Principal.
4. A student will be permitted to register in the next semester only if he fulfills the following conditions.
    - i Satisfied all the Academic Requirements to continue with the programme of Studies without termination.
    - ii Cleared all Institute, Hostel and Library dues and fines (if any) of the previous semesters;
    - iii Paid all required advance payments of the Institute and hostel for the current semester;
    - iv Not been debarred from registering on any specific ground by the Institute.

Evaluation System:

1. Absolute grading system based on absolute marks as indicated below will be implemented from academic year 2024-25, from 1st year B. Tech.

Percentage of marks	Letter Grade	Grade Point
91-100	EX	10.0
86-90	AA	9.0
81-85	AB	8.5
76-80	BB	8.0
71-75	BC	7.5
66-70	CC	7.0
61-65	CD	6.5
56-60	DD	6.0
51-55	DE	5.5
40-50	EE	5.0
<40	FF	0.0

2. Class is awarded based on CGPA of all eighth semester of B.Tech Program.

CGPA for pass is minimum 5.0	
CGPA upto <5.50	Pass class
CGPA ≥ 5.50&<6.00	Second Class
CGPA ≥ 6.00&<7.5	First Class
CGPA >7.50	Distinction
[Percentage of Marks =CGPA*10.0]	

3. A total of 100 Marks for each theory course are distributed as follows:

Mid Semester Exam (MSE) Marks	20
Continuous Assessment Marks	20
End Semester Examination (ESE) Marks	60

4. A total of 100 Marks for each practical course are distributed as follows:

1.	Continuous Assessment Marks	60
2.	End Semester Examination (ESE)Marks	40

- It is mandatory for every student of B. Tech to score a minimum of 40 marks out of 100, M. Tech to score a minimum of 45 marks out of 100 with a minimum of 20 marks out of 60 marks in End Semester Examination for theory course.
- This will be implemented from the first year of B. Tech starting from Academic Year 2024-25.

5. **Description of Grades**

- EX Grade: An “EX” grade stands for outstanding achievement.
- EE Grade: The “EE” grade stands for minimum passing grade.
- FF Grade: The “FF” grade denotes very poor performance, i.e. failure in a course due to poor performance. The students who have been awarded ‘FF’ grade in a course in any semester must repeat the subject in next semester.

6. Evaluation of Performance

a. Semester Grade Point Average (SGPA)

The performance of a student in a semester is indicated by Semester Grade Point Average (SGPA) which is a weighted average of the grade points obtained in all the courses taken by the student in the semester and scaled to a maximum of 10. (SGPI is to be calculated up to two decimal places). A Semester Grade Point Average (SGPA) will be computed for each semester as follows:

$$SGPA = \frac{[\sum_{i=1}^{n} c_i g_i]}{[\sum_{i=1}^{n} c_i]}$$

Where

"*n*" is the number of subjects for the semester,

"c_i" is the number of credits allotted to a particular subject, and

"g_i" is the grade-points awarded to the student for the subject based on his performance as

per the above table.

SGPA will be rounded off to the second place of decimal and recorded as such.

b. Cumulative Grade Point Average (CGPA):

An up to date assessment of the overall performance of a student from the time he entered the Institute is obtained by calculating Cumulative Grade Point Average (CGPA) of a student. The CGPA is weighted average of the grade points obtained in all the courses registered by the student since s/he entered the Institute. CGPA is also calculated at the end of every semester (upto two decimal places).Starting from the first semester at the end of each semester (S), a Cumulative Grade Point Average (CGPA) will be computed as follows:

$$CGPA = \frac{[\sum_{i=1}^{m} c_i g_i]}{[\sum_{i=1}^{m} c_i]}$$

Where,

"m" is the total number of subjects from the first semester onwards up to and including the semester S,

"ci" is the number of credits allotted to a particular subject, and

"gi" is the grade-points awarded to the student for the subject based on his/her performance as per the above table.

CGPA will be rounded off to the second place of decimal and recorded as such.

c. Attendance Requirements:

i. All students must attend every lecture, tutorial and practical classes.

ii. To account for approved leave of absence (eg. representing the Institute in sports, games or athletics; placement activities; NCC/NSS activities; etc.) and/or any other such contingencies like medical emergencies, etc., the attendance requirement shall be a minimum of 75% of the classes actually conducted. If the student failed to maintain 75% attendance, he/she will be detained for appearing the successive examination. The Dean (Academics)/ Principal is permitted to give 10% concession for the genuine reasons as such the case may be. In any case the student will not be permitted for appearing the examination if the attendance is less than 65%.

iii. The course instructor handling a course must finalize the attendance 3 calendar days before the last day of classes in the current semester and communicate clearly to the students by displaying prominently in the department and also in report writing to the head of the department concerned.

iv. The attendance records are to be maintained by the course instructor and he shall show it to the student, if and when required.

d. Transfer of Credits:

The courses credited elsewhere, in Indian or foreign University/Institutions/ Colleges/Swayam Courses by students during their study period at DBATU may count towards the credit requirements for the award of degree. The guidelines for such transfer of credits are as follows:

a. 20 % of the total credit will be considered for respective calculations.

b. Credits transferred will be considered for overall credits requirements of the programme.

c. Credits transfer can be considered only for the course at same level i.e UG, PG etc.

d. A student must provide all details (original or attested authentic copies) such as course contents, number of contact hours, course instructor /project guide and evaluation system for the course for which he is requesting a credits transfer. He/she shall also provide the approval or acceptance letter from the other side. These details will be evaluated by the concerned Board of Studies before giving approval. The Board of Studies will then decide the number of equivalent credits the student will get for such course(s) in DBATU. The complete details will then be forwarded to Dean for approval.

e. A student has to get minimum passing grades/ marks for such courses for which the credits transfers are to be made.

f. Credits transfers availed by a student shall be properly recorded on academic record(s) of the student.

g. In exceptional cases, the students may opt for higher credits than the prescribed.

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B. Tech Electronics and Computer Engineering /

B. Tech Electronics and Computer Science

In line with National Education Policy 2020 guidelines
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Third Year Teaching and Evaluation Scheme

Semester V												
Sr. No.	**Course Category**	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**Credit**
				L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
1	**PCC**	26AF1844PC501	Digital Signal and Image Processing	3	0	0	20	20	60	100	3
2	**PCC Lab**	26AF1844PC502L	Digital Signal and Image Processing Lab	0	0	2	60	--	40	100	1
3	**PCC**	26AF1844PC503	Database Management Systems	3	0	0	20	20	60	100	3
4	**PCC Lab**	26AF1844PC504L	Database Management Systems Lab	0	0	2	60	--	40	100	1
5	**OE**	26AF1XXXOE505	**Open Elective Bucket****	3	0	0	20	20	60	100	3
6	**MDM**	26AF1844MD506	**MDM Bucket***	3	0	0	20	20	60	100	3
7	**PCC**	26AF1844PC507	Embedded Systems	3	0	0	20	20	60	100	3
8	**PCC Lab**	26AF1844PC508L	Embedded Systems Lab	0	0	2	60	--	40	100	1
9	**PEC**	26AF1844PE509A 26AF1844PE509B 26AF1844PE509C	**Program Elective - I** A. Machine Learning^ B. Foundations of Cybersecurity C. Fundamentals of VLSI Design	3	0	0	20	20	60	100	3
10	**VSEC**	26AF1844VS510A 26AF1844VS510B	**Skill Programs:** A. Mobile App Development B. Electronic Product Development	1	0	2	60	--	40	100	2
			Total	19	0	8	360	120	520	1000	23

NOTE: *Refer to Multidisciplinary Minor Bucket of other Departments
**** Refer to Open Elective Bucket available on University Website**
^Not to be selected if MDM in AI&ML is opted.

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Third Year Teaching and Evaluation Scheme

Semester VI												
Sr. No.	**Course Category**	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**Credit**
				L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
1	**PCC**	26AF1844PC601	Design and Analysis of Algorithm	3	0	0	20	20	60	100	3
2	**PCC Lab**	26AF1844PC602L	Design and Analysis of Algorithm Lab	0	0	2	60	-	40	100	1
3	**PCC**	26AF1844PC603	Internet of Things	3	0	0	20	20	60	100	3
4	**PCC Lab**	26AF1844PC604L	Internet of Things Lab	0	0	2	60	-	40	100	1
5	**PEC**	26AF1844PE605A 26AF1844PE605B 26AF1844PE605C	**Program Elective - II** A. Deep Learning^ B. Network Security and Ethical Hacking C. Digital IC Design using Verilog HDL	3	0	0	20	20	60	100	3
6	**MDM**	26AF1844MD606	**MDM Bucket***	3	0	0	20	20	60	100	3
7	**PEC**	26AF1844PE607A 26AF1844PE607B 26AF1844PE607C	**Program Elective – III** A. Natural Language Processing^ B. Modern Communication Systems C. Full Stack Development	3	0	0	20	20	60	100	3
8	**PCC**	26AF1844PE608	Computer Networks	3	0	0	20	20	60	100	3
9	**PCC Lab**	26AF1844PE609L	Computer Networks Lab	0	0	2	60	-	40	100	1
			Total	**17**	**0**	**10**	360	120	520	1000	**21**

NOTE: *Refer to Multidisciplinary Minor Bucket of other Departments
**** Refer to Open Elective Bucket available on University Website**
^Not to be selected if MDM in AI&ML is opted.

Credit Distribution

SEM I	SEM II	SEMIII	SEM IV	SEM V	SEM VI	SEM VII	SEM VIII	TOTAL
21	23	23	23	23	21	23	19	176

BSC / ESC	Program Courses (PCC & PEC)	Multidisciplinary Courses (MDM & OE)	Skill Courses (VSEC)	Humanities Social Science and Management (HSSM) (IKS, VEC, AEC)	Experiential Learning Courses (CEP & FP)	Liberal Learning Courses (CC)	TOTAL
34	70	22	8	16	22	4	176

Semester		**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total Credits**	
Basic Science Course	BSC/ESC	7	7	3	0	0	0	0	0	17	**34**
Engineering Science Course		7	10	0	0	0	0	0	0	17	
Programme Core Course (PCC)	Program Courses	0	0	8	11	12	12	7	3	53	**70**
Programme Elective Course (PEC)		0	0	0	0	3	6	6	2	17	
Multidisciplinary Minor (MDM)	Multidisciplinary Courses	0	0	2	2	3	3	2	2	14	**22**
Open Elective (OE) Other than a particular program		0	0	2	3	3	0	0	0	8	
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	02	02	0	2	2	0	0	0	8	**8**
Ability Enhancement Course (AEC -01, AEC-02)	Humanities Social Science and Management (HSSM)	03	0	0	2	0	0	0	0	5	**16**
Entrepreneurship/Economics/ Management Courses		0	0	2	2	0	0	0	0	4	
Indian Knowledge System (IKS)		0	02	0	0	0	0	0	0	2	
Value Education Course (VEC)		0	0	4	1	0	0	0	0	5	
Research Methodology	Experiential Learning Courses	0	0	0	0	0	0	4	0	4	**22**
Comm. Engg. Project (CEP)/Field Project (FP)		0	0	2	0	0	0	0	0	2	
Project		0	0	0	0	0	0	4	0	4	
Internship / OJT		0	0	0	0	0	0	0	12	12	
Co-curricular Courses (CC)	Liberal Learning Courses	02	02	0	0	0	0	0	0	4	**4**
Total Credits (Major)		21	23	23	23	23	21	23	19	176	**176**

THIRD YEAR

SEMESTER V

26AF1844PC501	Digital Signal and Image Processing	03 Credits

Course Objectives:

The objective of this course is to:

1. Understand the fundamentals of discrete signals, systems, signal operations, sampling, and system classifications.
2. Explain Fourier Transform, Discrete Fourier Transform (DFT), Z-Transform, and convolution techniques for signal analysis.
3. Understand the fundamentals of digital image processing, image representation, digitization, and basic image operations.
4. Apply image enhancement techniques, spatial filtering, and image transformation methods for image processing applications.
5. Analyze morphological image processing operations and image segmentation techniques for feature extraction.

Course Outcomes:

After completing this course, students will be able to:

CO1: Classify signals and systems and perform fundamental signal operations and sampling.

CO2: Apply Fourier Transform, DFT, Z-Transform, and convolution techniques for discrete-time signal analysis.

CO3: Explain image representation, digitization, and basic operations used in digital image processing.

CO4: Implement image enhancement, spatial filtering, and image transformation techniques for improving image quality.

CO5: Analyse images using morphological operations and segmentation methods for object and feature extraction.

Unit-I: Introduction to Discrete Signals and Systems **08 Hours**

Signals: Definition of signal and systems, Continuous time and time signal, Classification of signals as even, odd, periodic and non-periodic, deterministic and nondeterministic, energy and power, elementary signals used for testing: exponential, sine, impulse, step, ramp, rectangular, triangular, signum, sinc. Operations on signals: Amplitude scaling, addition, multiplication, time scaling, time shifting and time folding. Sampling Process. Systems: Definition, Classification: linear and non-linear, time variant and invariant, causal and non-causal, static and dynamic, stable and unstable, invertible.

Unit-II: Transformations **08 Hours**

Fourier Transform: DTFT, Definition, Frequency domain sampling, DFT, Properties of DFT, Convolution: circular convolution, linear convolution. Z- Transform: Need for transform, relation between Laplace transform and Z transform, between Fourier transform and Z transform, Properties of ROC and properties of Z transform, Inverse Z transform, Power series method, partial fraction expansion method.

Unit-III: Introduction to Digital Image Processing **08 Hours**

Motivation & Perspective, Applications, Types of images, image file formats, Fundamentals Steps in Image Processing, Components of Image Processing System, Image digitization, Some basic relationships, Distance Measures between pixels, Image basic operation, Special Operations.

Unit-IV: Image Enhancement and Transformation **08 Hours**

Image Enhancement: Introduction, Methods, Basic Intensity Transformation: Image Negatives, Log transformation, Power law Transformation, piecewise linear transformation functions, Histogram processing, Histogram Equalization and Matching. Basics of Spatial Filters: 2D Convolution & 2D Correlation, Smoothening (LPF) (Linear: Box, Gaussian & Non Linear: Median) and Sharpening (HPF): Laplacian operators. Image Transforms: Discrete Fourier transform (DFT): Definition and properties and FFT.

Unit-V: Morphological operations and segmentation **08 Hours**

Introduction, erosion, dilation, opening, closing, Hit or Miss, boundary extraction, hole filling, connected components, thinning, thickening, and skeletonization. Segmentation: Basics of edge detection: Image gradient and operators, Thresholding: Intensity Thresholding, Global thresholding, Segmentation by region growing, region splitting and merging.

Text Books

1. Dr. S. L. Nalbalwar, A.M. Kulkarni and S.P. Sheth, “Signals and Systems”, 2nd Edition, Synergy Knowledgeware,2017
2. Nagoor Kanni “Signals and Systems”, 2nd edition, McGrawHill.
3. R. C. Gonzalez, R. E. Woods. Digital Image Processing. Addison Wesley Longman, Inc.,4th Edition, 2018.

Reference Books:

1. Alan V. Oppenheim. Alan S. Willsky and S. Hamid Nawab, “Signals and Systems”,PHI
2. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1989.
3. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms And Applications, Prentice Hall, 1997.
4. D. H. Ballard, C. M. Brown. Computer Vision. Prentice-Hall, Englewood Cliffs, 1982.
5. Richard Szeliski, Computer Vision: Algorithms and Applications (CVAA). Springer, 2010
6. Image Processing, Analysis, and Machine Vision. Sonka, Hlavac, and Boyle. Thomson.

NPTEL / SWAYAM Courses

1. Digital Image Processing, by Prof. Prabir Kumar Biswas IIT Kharagpur https://nptel.ac.in/courses/117105135
2. Computer Vision And Image Processing - Fundamentals And Applications, by Prof. M.K. Bhuyan, IIT Guwahati . https://nptel.ac.in/courses/108103174

26AF1844PC502L	Digital Signal and Image Processing Lab	01 Credits

Course Objectives:

The objective of this course is to:

1. Understand and analyze continuous and discrete-time signals and systems using Python.
2. Implement signal transformations and convolution techniques for signal analysis.
3. Develop image processing applications using OpenCV and Python.
4. Apply image enhancement and transformation techniques for improving image quality.
5. Implement morphological operations and image segmentation for feature extraction.

Course Outcomes:

After completing this course, students will be able to:

CO1: Generate and analyze signals and systems using Python.

CO2: Apply signal transformations and convolution techniques for signal processing.

CO3: Implement image enhancement and transformation techniques using OpenCV.

CO4: Analyze images using filtering, frequency-domain processing, and histogram techniques.

CO5: Develop image segmentation and morphological processing applications for feature extraction.

List of Experiments:

1. Generation and visualization of elementary signals (Impulse, Step, Ramp, Sinusoidal, Exponential) using Python.
2. Implementation of basic signal operations:
    a. Amplitude Scaling
    b. Time Shifting
    c. Time Scaling
    d. Time Reversal
    e. Signal Addition and Multiplication
3. Classification of signals
    a. Even/Odd
    b. Energy/Power
    c. Periodic/Non-Periodic
4. Implementation of sampling and reconstruction of continuous-time signals.
5. Simulation and verification of properties of Linear Time-Invariant (LTI) systems.
6. Implementation of Linear Convolution and Circular Convolution using Python.
7. Computation and visualization of Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT).
8. Frequency spectrum analysis of different signals using FFT.
9. Implementation of Z-Transform and Inverse Z-Transform for simple discrete-time signals.
10. Verification of properties of DFT using Python.
11. Image acquisition, reading, displaying, and saving images using OpenCV.
12. Image color space conversion:
    a. RGB to Gray
    b. RGB to HSV
    c. RGB to Binary
13. Image manipulation:
    a. Cropping
    b. Resizing

    c. Rotation
    d. Flipping
14. Pixel-level operations and image arithmetic.
15. Implementation of intensity transformation techniques:
    a. Negative
    b. Log
    c. Gamma Correction
16. Histogram analysis and Histogram Equalization.
17. Image smoothing using:
    a. Mean Filter
    b. Gaussian Filter
    c. Median Filter
18. Image sharpening using:
    a. Laplacian Filter
    b. High Boost Filtering
19. Frequency domain image processing using DFT and FFT.
20. Implementation of Morphological Operations:
    a. Erosion
    b. Dilation
    c. Opening
    d. Closing
21. Boundary extraction and hole filling using morphological operations.
22. Edge detection using:
    a. Sobel
    b. Prewitt
    c. Canny Operators
23. Image thresholding:
    a. Global Thresholding
    b. Adaptive Thresholding
    c. Otsu Thresholding
24. Image segmentation using:
    a. Region Growing
    b. Connected Component Analysis
25. Mini Project: Image Processing Application using Python and OpenCV.

Text Books

1. Robert Laganière, OpenCV 4 Computer Vision Application Programming Cookbook, Packt Publishing, ISBN-13: 978-1803237244, 4th Edition.
2. Jan Erik Solem, Programming Computer Vision with Python, O'Reilly Media, ISBN-13: 978-1449316549, 1st Edition.
3. R. C. Gonzalez, R. E. Woods. Digital Image Processing. Addison Wesley Longman, Inc.,4th Edition, 2018.

Reference Books:

1. Joe Minichino, Joseph Howse, Learning OpenCV 4 Computer Vision with Python, Packt Publishing, ISBN-13: 978-1789531619, 3rd Edition.
2. Adrian Rosebrock, Practical Python and OpenCV, PyImageSearch, Latest Edition.
3. Abhinav Dadhich, Hands-On OpenCV using Python, BPB Publications, Latest Edition.

26AF1844PC503	Database Management Systems	03 Credits

Course Objectives:

The objective of this course is to provide students with

1. Understand database concepts, database architectures, data models, database languages, and modern data management systems including cloud databases and DBaaS.
2. Explain the database connectivity frameworks using SQL, PL/SQL, and transaction control for database application development.
3. Apply relational database design principles using ER modeling, relational algebra, functional dependencies, and normalization techniques.
4. Analyze query processing, indexing, transaction management, concurrency control, and database recovery techniques for efficient database performance.
5. Evaluate advanced database architectures, distributed and parallel databases, NoSQL databases, MongoDB, and cloud-based data management technologies.

Course Outcomes:

After completing this course, students will be able to

CO1: Explain database concepts, DBMS architecture, database languages, data models, cloud database concepts and applications of modern data management systems.

CO2: Apply knowledge of SQL, PL/SQL, and transaction control for database application development using database connectivity frameworks.

CO3: Design relational databases by applying ER modeling, relational algebra, functional dependencies, normalization, and database design principles.

CO4: Analyze query processing, query optimization, indexing methods, transaction management, concurrency control, and database recovery mechanisms.

CO5: Apply advanced database technologies including distributed databases, and NoSQL databases to design scalable database solutions.

Unit-I: Database Concepts **08 Hours**

Introduction to Database Systems, File System vs Database System, Database Users and Applications, Data Abstraction and Data Independence, DBMS Architecture, Database Languages (DDL, DML, DCL, TCL), Data Models: Hierarchical, Network, Relational, Object-Oriented, Introduction to Cloud Database Concepts, Database as a Service (DBaaS), Big Data Storage Systems, Applications of Modern Data Management Systems.

Unit-II: SQL, PL/SQL and Database Programming **08 Hours**

SQL Fundamentals, DDL, DML, DCL and TCL Commands, Joins and Subqueries, Clauses: Group By, Where, Having, Distinct, Limit, Set Operations, Aggregate Functions and Grouping, Views and Indexes, Transactions: Commit, Rollback, Savepoint, Triggers, PL/SQL Fundamentals, Stored Procedures and Functions, Cursors and Exception Handling, JDBC and ODBC Connectivity, Database Application Development

Unit-III: Relational Database Design **08 Hours**

Entity-Relationship (ER) Model, Entities, Attributes, Relationships, Constraints, Keys and ER Diagrams, ER Model Case studies: Hospital Management System, Library Management System, Converting ER Diagram to Relational Database, Relational Algebra Operations, Functional Dependencies, Normalization (1NF, 2NF, 3NF, BCNF), Database anomalies: Insertion, Update & Deletion Anomalies, Decomposition and Dependency Preservation.

Unit-IV: Query Processing and Transaction Management **08 Hours**

Query Processing: Query cost estimation, Selection and Join operations, Evaluation of expressions. Query Optimization: Transformation of relational expressions, Cost-based approaches (overview). Indexing & Hashing: B-trees, B+ trees, Hashing techniques, Multi-attribute indexes. Transaction Management: ACID properties, Schedules, Concurrency Control (lock-based, serializability, deadlocks, control without locking). Database Recovery: Failure classification, Log-based recovery, Shadow paging, advanced recovery techniques.

Unit-V: Advanced Database Systems and NoSQL Databases **08 Hours**

Multi-user Database Architectures: Parallel Database Systems, Distributed Database Systems, CAP Theorem, Introduction to NoSQL Databases: Types of NoSQL Databases, Document-Oriented Databases, MongoDB Architecture: CRUD Operations in MongoDB, Indexing and Aggregation, Replication and Sharding, XML and JSON Databases

Text Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, McGraw Hill Education, ISBN-13: 978-9332901383, 7th Edition.
2. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, Pearson Education, ISBN-13: 978-9356069237, 7th Edition.
3. Carlos Coronel, Steven Morris, Peter Rob, Database Systems: Design, Implementation and Management, Cengage Learning, ISBN-13: 978-1337627900, 13th Edition.

Reference Books:

1. Pramod J. Sadalage, Martin Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Addison-Wesley Professional, ISBN-13: 978-0321826626, 1st Edition.
2. Kristina Chodorow, MongoDB: The Definitive Guide, O'Reilly Media, ISBN-13: 978-1491954461, 3rd Edition.
3. Paulraj Ponniah, Data Warehousing Fundamentals for IT Professionals, Wiley India, ISBN-13: 978-8126530779, 3rd Edition.

NPTEL Courses:

1. Introduction to Database Systems- Prof. Sreenivasa Kumar, IIT Madras https://onlinecourses.nptel.ac.in/noc26_cs72/preview
2. Data Base Management System- Prof. Partha Pratim Das, Prof. Samiran Chattopadhyay, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc26_cs39/preview
3. Data Analytics with Python by Prof. Ragunathan Rengaswamy, IIT Madras. https://nptel.ac.in/courses/106107220

26AF1844PC504L	Database Management Systems Lab	01 Credits

Course Objectives:

The objective of this course is to:

1. Develop skills in designing and implementing relational databases using SQL.
2. Enable students to create and manage database objects, queries, and transactions.
3. Provide hands-on experience in PL/SQL programming for database applications.
4. Familiarize students with database connectivity and NoSQL database operations.
5. Develop the ability to design, optimize, and deploy database-driven applications for real-world scenarios.

Course Outcomes:

After completing this course, students will be able to:

CO1: Design and create relational database schemas using SQL and normalization principles.

CO2: Develop SQL queries, views, indexes, and transaction-based applications for database management.

CO3: Implement PL/SQL programs using procedures, functions, triggers, and cursors.

CO4: Develop database applications using JDBC/ODBC connectivity and NoSQL databases.

CO5: Design and optimize database solutions for practical applications using relational and non-relational databases.

List of Experiments:

1. Installation and Configuration of DBMS Software (MySQL) and study Architecture/Structure of Database Management System.
2. Creation of database schema using DDL commands.
3. Implementation of integrity constraints (Primary Key, Foreign Key, Unique, Check, Not Null).
4. Execution of basic SQL queries using DML commands (Insert, Update, and Delete).
5. Implementation of SQL operators and functions.
6. Use of aggregate functions, grouping, and set operations.
7. Implementation of joins (Inner, Outer, Self, Cross) and subqueries.
8. Execution of subqueries using various clauses.
9. Creation and use of views and indexes.
10. Database connectivity using JDBC/Python and MySQL/MongoDB.
11. Transaction management using Commit, Rollback, and Savepoint.
12. Installation and configuration of MongoDB.
13. CRUD operations in MongoDB.
14. Implementation of document-based data modeling in MongoDB.
15. Mini Project: Perform basic CRUD operation by developing any of the following system using GUI, MySQL/MongoDB
    a. Library Management System
    b. Railway Ticket Booking System
    c. Hospital Management System

26AF1844PC507	Embedded Systems	03 Credits

Course Objectives:

The objective of this course is to:

1. Understand the architecture, characteristics, design methodology, and applications of embedded systems.
2. Develop embedded applications using the ESP32 platform and its programming environment.
3. Implement embedded systems by interfacing sensors, actuators, displays, and communication peripherals.
4. Apply Embedded Linux concepts and Raspberry Pi programming for embedded application development.
5. Understand Real-Time Operating System (RTOS) concepts and develop multitasking embedded applications using FreeRTOS.

Course Outcomes:

After completing this course, students will be able to

CO1: Explain the architecture, characteristics, design methodology, and applications of embedded systems.

CO2: Develop embedded applications using the ESP32 platform and embedded programming techniques.

CO3: Implement sensor, actuator, display, and communication interfaces using standard embedded communication protocols.

CO4: Apply Embedded Linux concepts and Raspberry Pi programming for embedded system development.

CO5: Develop real-time embedded applications using RTOS concepts, task scheduling, synchronization, and FreeRTOS.

Unit-I: Fundamentals of Embedded Systems **08 Hours**

Introduction to Embedded Systems, Characteristics and Classification of Embedded Systems, Embedded System Architecture, Hardware Components: Microcontroller, Microprocessor, System-on-Chip (SoC), Embedded Software Components, Embedded System Design Flow, Design Metrics and Constraints, Applications of Embedded Systems

Unit-II: ESP32 and Embedded Development **08 Hours**

Introduction to ESP32: Functional Block Diagram, Features; SoC vs Modules vs Development Boards; ESP32 NodeMCU: Pin configuration, ESP32 Development Environment: Arduino IDE, PlatformIO (Overview), ESP32 GPIO Programming: Digital Input and Output, LED and Push Button Interfacing; PWM Controller: LED Dimming and Motor Control, Timers and Interrupts Programming, (Use of Embedded C programming)

Unit-III: ESP32 Embedded Interfacing **08 Hours**

ADC and DAC Concepts, Analog Sensor Interfacing: Potentiometer, LDR, Soil Moiture Sensor, LM35 Temperature Sensor, MQ Series Gas Sensors; Digital Sensor Interfacing: DHT11/22 Temperature and Humidity Sensor, HC-SR04 Distance Sensor, Actuator Interfacing: Relay, Buzzer, Solenoid Valve, Display Interfacing: LCD, Communication Protocols: UART, I²C, SPI Interface (Using ESP32 only)

Unit-IV: Raspberry Pi and Embedded Linux **08 Hours**

Overview of Raspberry Pi: Introduction to Raspberry Pi, Comparison of various Rpi Models, Understanding SoC architecture and SoCs used in Raspberry Pi, Pin Description of Raspberry Pi , On-board components of Rpi. Introduction to Embedded Linux, Features of Embedded Linux, Raspberry Pi OS Installation and Configuration, Linux Commands: File viewing and editing, System information, Package management, configuration commands, network commands and and python execution commands; GPIO Programming using Python: LED, Switch, DHT11/22, Ultrasonic Sensor Interfacing.

Unit-V: RTOS Programming and Applications **08 Hours**

Introduction to FreeRTOS, FreeRTOS Kernel Architecture, FreeRTOS on ESP32; Task Creation and Management, Task Synchronization and Communication, Memory Management in RTOS, Interrupt Handling in RTOS, Real-Time Application Development using FreeRTOS, Case Studies: Real-time sensor monitoring and multitasking using ESP32.

Text Books:

1. Raj Kamal, Embedded Systems: Architecture, Programming and Design, McGraw Hill Education, ISBN-13: 978-9354602689, 3rd Edition.
2. Shibu K. V., Introduction to Embedded Systems, McGraw Hill Education, ISBN-13: 978-0070145894, 2nd Edition.
3. Simon Monk, Programming the Raspberry Pi: Getting Started with Python, McGraw-Hill Education, ISBN-13: 978-1259587405, 3rd Edition.

Reference Books:

1. Frank Vahid, Tony Givargis, Embedded System Design: A Unified Hardware/Software Introduction, Wiley India, ISBN-13: 978-8126523696, 2nd Edition.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide: Designing and Optimizing System Software, Morgan Kaufmann / Elsevier, ISBN-13: 978-1558608740, 1st Edition.
3. Richard Barry, Mastering the FreeRTOS Real Time Kernel, Real Time Engineers Ltd., Latest Edition.

NPTEL Courses:

1. NPTEL Course: Embedded System Design with ARM by Prof. Indranil Sengupta and Prof. Kamalika Datta, IIT Kharagpur. https://nptel.ac.in/courses/106105193
2. NPTEL Course: Introduction to Real Time Embedded Systems – Part I by Prof. Rajib Mall, Prof. Amit Patra and Prof. A. Routray, IIT Kharagpur. https://nptel.ac.in/courses/108105057
3. NPTEL Course: Operating System Fundamentals by Prof. Santanu Chattopadhyay, IIT Kharagpur. https://nptel.ac.in/courses/106105214

26AF1844PC508L	Embedded Systems Lab	01 Credits

Course Objectives:

The objective of this course is to:

1. Develop embedded applications using ESP32 and Raspberry Pi development platforms.
2. Interface sensors, actuators, and peripheral devices using GPIO and communication protocols.
3. Implement Embedded Linux applications using Raspberry Pi and Python.
4. Apply RTOS concepts for multitasking and task synchronization in embedded systems.
5. Design and demonstrate embedded solutions for real-world applications.

Course Outcomes:

After completing this course, students will be able to:

CO1: Configure and program ESP32 and Raspberry Pi for embedded system development.

CO2: Interface sensors, actuators, displays, and communication peripherals with embedded platforms.

CO3: Develop Embedded Linux applications using Raspberry Pi and Python.

CO4: Implement multitasking embedded applications using FreeRTOS.

CO5: Design and integrate hardware and software components to develop real-time embedded applications.

List of Experiments: (Select min 10 experiments and distributed unit-wise)

1. Installation and configuration of Arduino IDE/PlatformIO and ESP32 development environment.
2. GPIO programming: LED blinking, push-button interfacing, and digital input/output operations.
3. PWM generation for LED brightness control and servo motor interfacing.
4. Interfacing temperature and humidity sensor (DHT11/DHT22) with ESP32.
5. Interfacing ultrasonic/LDR/IR sensor and displaying sensor data.
6. LCD/OLED display interfacing using I²C.
7. UART communication between ESP32 and PC/another microcontroller.
8. SPI or I²C communication with peripheral devices.
9. Installation and configuration of Raspberry Pi OS and familiarization with Linux commands.
10. GPIO programming on Raspberry Pi using Python (LED and push-button interfacing).
11. Interfacing sensors (Temperature/Ultrasonic) with Raspberry Pi using Python.
12. Creating multiple tasks using FreeRTOS.
13. Task synchronization using semaphores and mutexes.
14. Inter-task communication using queues and timers.
15. Mini Project: Design and implement a real-time embedded application using ESP32/Raspberry Pi and FreeRTOS.

26AF1844PE509A	Machine Learning	03 Credits

Course Objectives:

The objective of this course is to:

1. Understand the fundamental concepts and mathematical foundations of Machine Learning.
2. Analyze different supervised and unsupervised learning algorithms.
3. Develop predictive models using machine learning techniques.
4. Evaluate machine learning models using appropriate performance metrics.
5. Apply machine learning techniques to solve real-world engineering problems.

Course Outcomes:

After completing this course, students will be able to:

CO1: Explain machine learning concepts and data preprocessing techniques.

CO2: Apply supervised learning algorithms for classification and regression problems.

CO3: Analyze unsupervised learning techniques for clustering and dimensionality reduction.

CO4: Evaluate machine learning models using suitable validation methods and performance measures.

CO5: Develop machine learning solutions for practical engineering applications.

Unit-I: Introduction to Machine Learning **08 Hours**

Introduction, Applications of Machine Learning, Types of Learning (Supervised, Unsupervised, Reinforcement), Machine Learning Workflow, Training and Testing Data, Hypothesis Space and Inductive Bias (basic concepts), Model Evaluation, Training, Validation and Testing, Cross-Validation (overview), Introduction to Feature Selection and Feature Reduction.

Unit-II: Supervised Learning **08 Hours**

Linear Regression, Logistic Regression, Decision Trees, Instance-Based Learning (K-Nearest Neighbors), Support Vector Machine (basic concept), Overfitting and Underfitting, Model Performance Evaluation (Accuracy, Precision, Recall, F1-Score), Introduction to Recommendation Systems, Collaborative Filtering (overview).

Unit-III: Unsupervised Learning **08 Hours**

Introduction, Clustering Concepts, K-Means Clustering, Hierarchical Clustering (overview), Gaussian Mixture Model (basic concept), Applications of Clustering in Business, Healthcare, Marketing, and Customer Segmentation.

Unit-IV: Neural Networks and Deep Learning **08 Hours**

Introduction, Perceptron Model, Multilayer Neural Networks, Backpropagation (basic concept), Introduction to Deep Learning, Applications of Deep Neural Networks in Image Recognition, Speech Processing, Healthcare, and Smart Systems.

Unit-V: Reinforcement Learning **08 Hours**

Fundamentals of Reinforcement Learning, agent, environment, state, action, reward, policy, value function, Markov Decision Process (MDP), exploration–exploitation trade-off, and applications of Reinforcement Learning.

Text Books

1. Tom Mitchell, Machine Learning, First Edition, McGraw Hill, 1997.
2. Ethem Alpaydin, Introduction to Machine Learning, Prentice Hall India Learning Private Limited; 2nd edition, 2010.

Reference Books:

1. Christopher Bishop, Pattern Recognition and Machine Learning, Springer.
2. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, the Elements of Statistical Learning, Springer.

NPTEL / SWAYAM Courses

1. Foundations of Machine Learning, Prof. J. SakethaNath, IIT Hyderabad, https://nptel.ac.in/courses/106106001
2. Introduction to Machine Learning, Prof. Balaraman Ravindran, IIT Madras https://nptel.ac.in/courses/106106139

26AF1844PE509B	Foundations of Cybersecurity	03 Credits

Course Objectives:

The objective of this course is to:

1. Understand the fundamental concepts, principles, and challenges of cybersecurity.
2. Learn various cyber threats, attacks, vulnerabilities, and defense mechanisms.
3. Understand cryptographic techniques used to ensure confidentiality, integrity, and authentication.
4. Explore network, system, and application security mechanisms.
5. Develop awareness of security policies, cyber ethics, legal issues, and risk management practices.

Course Outcomes:

After completing this course, students will be able to:

CO1: Explain cybersecurity concepts, threat landscapes, and security principles.

CO2: Analyze common cyber-attacks, vulnerabilities, and corresponding defense mechanisms.

CO3: Apply cryptographic techniques and security protocols to secure information systems.

CO4: Evaluate security mechanisms used in networks, operating systems, and applications.

CO5: Assess cybersecurity risks, policies, legal requirements, and ethical considerations in digital environments.

Unit-I: Introduction to Cybersecurity **08 Hours**

Fundamentals of Cybersecurity, Cybersecurity Goals, CIA Triad, Threats, Vulnerabilities & Risks, Types of Cybersecurity, Security Principles, Cyber Attacks, Types of Security Standards, Cybersecurity Domains and Career Opportunities.

Unit-II: Cryptography and Information Security **08 Hours**

Introduction to Cryptography, Basic terminology: Plaintext, Ciphertext, Encryption, Decryption, key, Components of a cryptosystem, Symmetric Key Cryptography, Asymmetric Key Cryptography, Hash Functions and digital signatures, Applications of Cryptography ,Introduction to cyber laws and emerging trends in information security

Unit-III: Network Security **08 Hours**

Network Security Fundamentals, Common Network Attacks, Firewalls and IDS/IPS, Virtual Private Networks (VPNs), Secure Communication Protocols, Wireless Network Security, Email Security, Web Security Basics

Unit-IV: System and Application Security **08 Hours**

Operating System Security Concepts, User Authentication and Access Control, Password Security and Multi-Factor Authentication, Malware: Viruses, Worms, Trojans, Ransomware, Software Vulnerabilities, Secure Software, Development Practices, Endpoint Security, and Cloud Security Fundamentals

Unit-V: Cybersecurity Governance, Risk, and Ethics **08 Hours**

Cybersecurity Risk Management, Security Policies and Procedures, Incident Response and Disaster Recovery, Cyber Laws and Regulations, Digital Privacy and Data Protection, Ethical Hacking Concepts, Cybersecurity Compliance Standards, Emerging Trends in Cybersecurity

Text Books

1. Charles J. Brooks, Christopher Grow, Philip Craig, Donald Short, Cybersecurity Essentials, Wiley, ISBN-13: 978-1119362395, 1st Edition.
2. William Stallings, Cryptography and Network Security: Principles and Practice, Pearson Education, ISBN-13: 978-9353943837, 8th Edition.
3. Nina Godbole, Sunit Belapure, Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley India, ISBN-13: 978-8126551798, 2nd Edition.

Reference Books:

1. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Cengage Learning, ISBN-13: 978-0357506431, 7th Edition.
2. Joseph Migga Kizza, Guide to Computer Network Security, Springer, ISBN-13: 978-3030381837, 5th Edition.
3. Chuck Easttom, Computer Security Fundamentals, Pearson, ISBN-13: 978-0135774779, 5th Edition.

NPTEL / SWAYAM Courses

1. Introduction to Cyber Security by Prof. Dipankar Dasgupta, IIIT Sri City. https://nptel.ac.in/courses/106106220
2. Cyber Security and Privacy by Prof. Debdeep Mukhopadhyay, IIT Kharagpur. https://nptel.ac.in/courses/106105217
3. Introduction to Internet of Things and Cyber Security by Prof. Sudip Misra, IIT Kharagpur. https://nptel.ac.in/courses/106105166

26AF1844PE509C	Fundamentals of VLSI Design	03 Credits

Course Objectives:

The objective of this course is to:

1. Understand the fundamentals of semiconductor technology and VLSI design.
2. Explain CMOS fabrication processes and MOS transistor operation.
3. Design basic CMOS combinational and sequential logic circuits.
4. Apply layout design rules for CMOS integrated circuits.
5. Analyze the performance of CMOS circuits using EDA tools.

Course Outcomes:

After completing this course, students will be able to:

CO1 Explain the fundamentals of VLSI technology and CMOS fabrication.

CO2 Analyze MOS transistor characteristics and CMOS logic circuits.

CO3 Design CMOS combinational and sequential circuits.

CO4 Develop CMOS layouts following design rules.

CO5 Evaluate CMOS circuit metrics and scaling.

Unit-I: Introduction to VLSI Technology **08 Hours**

Introduction to Integrated Circuits, SSI, MSI, LSI, VLSI and ULSI, Moore's Law, Semiconductor materials, Silicon wafer manufacturing, IC classification, Full-custom, Semi-custom and ASIC design, VLSI Design Flow, Applications of VLSI in modern electronics

Unit-II: MOS Devices and CMOS Fundamentals **08 Hours**

Review of Semiconductor Physics, MOS Capacitor, Enhancement and Depletion MOSFET, NMOS and PMOS operation, CMOS inverter, Static characteristics, Dynamic characteristics, Noise margins, Propagation delay, and Power dissipation

Unit-III: CMOS Logic Circuit Design **08 Hours**

CMOS realization of combinational logic gates (NAND, NOR, XOR, XNOR), Design of complex CMOS logic circuits (AOI and OAI gates), Static CMOS and Dynamic CMOS logic, Pass Transistor Logic (PTL) and Transmission Gate Logic, CMOS sequential circuits: Latches and Flip-Flops, Introduction to SRAM, DRAM, and ROM architectures.

Unit-IV: CMOS Layout Design and VLSI Subsystems **08 Hours**

Stick diagrams and lambda-based design rules, CMOS layout of inverter, NAND, and NOR gates, Design Rule Check (DRC) and Layout versus Schematic (LVS), Floor-planning and standard cell concepts, Basic arithmetic circuits: Adders and Multipliers, Introduction to Electronic Design Automation (EDA) tools for VLSI design.

Unit-V: VLSI Design Metrics and Scaling **08 Hours**

Propagation delay and RC delay model, Static and dynamic power dissipation in CMOS circuits, Power optimization techniques: Clock gating and Power gating, CMOS scaling principles and technology scaling, Reliability issues: Electromigration, Hot Carrier Effect, and NBTI, Performance trade-offs among power, delay, and area.

Text Books

1. Neil H. E. Weste and David Harris, CMOS VLSI Design: A Circuits and Systems Perspective, 5th Edition, Pearson Education.
2. S. M. Kang and Yusuf Leblebici, CMOS Digital Integrated Circuits: Analysis and Design, 4th Edition, McGraw-Hill Education.
3. Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic, Digital Integrated Circuits: A Design Perspective, 2nd Edition, Pearson.

Reference Books:

1. Douglas A. Pucknell and Kamran Eshraghian, Basic VLSI Design, 3rd Edition, Prentice Hall.
2. Mead, C. and Conway, L., Introduction to VLSI Systems, Addison-Wesley.
3. Uyemura, John P., Introduction to VLSI Circuits and Systems, Wiley India.

NPTEL / SWAYAM Courses

1. VLSI Design Flow: RTL to GDS, Prof. Sneh Saurabh, IIT Delhi. https://nptel.ac.in/courses/108106191
2. CMOS Digital VLSI Design, Prof. Sudeb Dasgupta, IIT Roorkee https://nptel.ac.in/courses/108107129

26AF1844VS510A	Mobile Application Development	02 Credits

Course Objectives:

The objective of this course is to provide students with

1. To understand the fundamentals of mobile application development and Android development environment.
2. To develop skills for designing interactive and user-friendly mobile application interfaces.
3. To understand methods of storing and managing application data in mobile devices.
4. To learn integration of mobile applications with web services and external data sources.
5. To apply mobile application development concepts for building a complete application.

Course Outcomes:

After completing this course, students will be able to:

CO1: Create and execute a basic Android application using Android Studio.

CO2: Design responsive user interfaces using layouts and UI components.

CO3: implement local data storage and retrieval mechanisms in mobile applications. CO4: fetch, process, and display data from APIs in mobile applications.

CO5: develop, test, and deploy a functional mobile application project.

Unit-I: Introduction to Mobile Application Development **04 Hours**

Introduction to Mobile Computing, Mobile OS Overview (Android, iOS), Android Architecture, Android Studio Installation and Configuration, Project Structure and Application Lifecycle, Creating First Android Application.

Unit-II: User Interface Design and Layouts **04 Hours**

UI/UX Principles, Layouts: Linear, Relative, Constraint Layout, TextView, EditText, Button, ImageView, Event Handling and User Inputs, Menus and Navigation Components, Material Design Guidelines

Unit-III: Data Management and Storage **04 Hours**

Shared Preferences, File Handling, SQLite Database Basics, CRUD Operations, Data Validation Introduction to Room Database

Unit-IV: Connectivity and APIs **04 Hours**

Internet Permissions, HTTP and REST APIs, JSON Data Format, API Integration, Fetching and Displaying Data, Introduction to Firebase Services

Unit-V: Mobile Application Project Development **04 Hours**

Application Testing and Debugging, Performance Optimization, APK Generation, App Security Basics, Mini Project Development, Project Demonstration and Documentation.

List of Experiments: (Select any 10-12 Experiments from the list)

1. Installation and configuration of Android Studio and Android Emulator.
2. Create and run a simple Android application displaying text and images.
3. Study Android project structure and Activity Lifecycle using Logcat.
4. Develop a multi-screen Android application using Activities and Intents.
5. Design a user interface using LinearLayout and RelativeLayout.

6. Develop an application using ConstraintLayout and Material Design components.
7. Implement various UI controls such as TextView, EditText, Button, ImageView, CheckBox, and RadioButton.
8. Develop an application demonstrating event handling and user input validation.
9. Create an Android application using menus, toolbars, and navigation components.
10. Develop an application using Shared Preferences for storing user settings.
11. Implement file creation, reading, and writing operations in Android.
12. Create a SQLite database and perform Create, Insert, and Retrieve operations.
13. Implement Update and Delete operations using SQLite database.
14. Configure Internet permissions and connect an Android application to the internet.
15. Develop an application to fetch and parse JSON data from a public API.
16. Create an application to display API data using RecyclerView/ListView.
17. Integrate Firebase Authentication in an Android application.
18. Develop an application using Firebase Realtime Database or Firestore.
19. Debug and test Android applications using Android Studio tools.
20. Implement basic application security features such as input validation and secure storage.
21. Generate signed APK and prepare application for deployment.
22. Mini Project: Design and develop a complete Android application integrating UI, database, and API/Firebase functionality.

Text Books

1. Barry Burd, Android Application Development All-in-One For Dummies, Wiley Publications, ISBN-13: 978-1119301080, 3rd Edition.
2. Dawn Griffiths and David Griffiths, Head First Android Development, O'Reilly Media, ISBN-13: 978-1492076520, 3rd Edition.
3. Jerome F. DiMarzio, Beginning Android Programming with Android Studio, Wiley, ISBN-13: 978-1119808367, 5th Edition.

Reference Books

1. Reto Meier, Ian Lake, Professional Android, Wrox Publications, ISBN-13: 978-1119805472, 5th Edition.
2. Wei-Meng Lee, Beginning Android Application Development, Wiley Publications, ISBN-13: 978-1119808367, 5th Edition.
3. John Horton, Android Programming for Beginners, Packt Publishing, ISBN-13: 978-1803231297, 3rd Edition.

NPTEL / SWAYAM Courses

1. NPTEL Course: Mobile Computing by Prof. Pushpendra Singh, IIT Delhi. https://nptel.ac.in/courses/106106147
2. SWAYAM Course: Android Mobile Application Development by Dr. Babasaheb Ambedkar Open University. https://onlinecourses.swayam2.ac.in/nou21_ge41/preview
3. NPTEL Course: Introduction to Modern Application Development by Prof. Anand Chitipothu and Team, IIT Madras. https://nptel.ac.in/courses/106106156

26AF1844VS510B	Electronic Product Development	02 Credits

Course Objectives:

The objective of this course is to provide students with

1. Understand the stages and methodologies involved in electronic product development.
2. Learn component selection and hardware prototyping techniques for electronic products.
3. Develop programming skills for embedded systems used in electronic products.
4. Understand system integration and testing procedures for electronic products.
5. Understand product deployment aspects and implement a complete electronic product solution.

Course Outcomes:

After completing this course, students will be able to:

CO1: Identify product requirements and prepare basic design specifications.

CO2: Build and test a functional hardware prototype.

CO3: Interface sensors and peripherals with microcontroller-based systems

CO4: Perform integration, testing, and validation of electronic systems.

CO5: Develop and present a working electronic product prototype with proper documentation.

Unit-I: Introduction to Electronic Product Development Process **04 Hours**

Overview of Electronic Products, Product Development Lifecycle, Requirement Gathering and Specification, Market Analysis and Product Selection, Product Design Considerations, Design Documentation

Unit-II: Hardware Development and Prototyping **04 Hours**

Component Selection Techniques, Sensors and Actuators, Microcontrollers and Development Boards, Breadboard Prototyping, Power Supply Considerations, Hardware Testing Methods,

Unit-III: Embedded Software Development **04 Hours**

Embedded System Fundamentals, Programming Microcontrollers, Digital Input/Output Control, Sensor Interfacing, Communication Protocols (UART, I2C, SPI), Debugging Embedded Systems

Unit-IV: Product Integration, Testing and Validation **04 Hours**

System Integration Techniques, Functional Testing, Reliability and Performance Testing, Calibration Methods, Troubleshooting and Fault Analysis, Product Validation Procedures

Unit-V: Product Packaging, Commercialization and Mini Project **04 Hours**

Enclosure and Packaging Concepts, Product Cost Estimation, Safety and Regulatory Considerations Product Documentation and User Manual Preparation, Product Demonstration Techniques, Mini Project Development and Presentation.

List of Experiments: (Select any 10-12 Experiment from the list)

1. Study of electronic product development lifecycle and preparation of Product Requirement Specification (PRS) for a selected product.
2. Market survey and comparative analysis of existing electronic products in a chosen application domain.
3. Preparation of product specification sheet and block diagram for a selected electronic product.
4. Preparation of design documentation including functional requirements, hardware requirements, and software requirements.
5. Identification and selection of electronic components using datasheets.
6. Interfacing and testing of basic sensors (temperature, light, motion, or ultrasonic sensor).
7. Interfacing and testing of actuators (LED, relay, buzzer, servo motor).
8. Breadboard prototyping of a simple sensor-based system.
9. Design and testing of regulated power supply for embedded applications.
10. Hardware testing using multimeter, continuity tester, and oscilloscope.
11. Programming a microcontroller/development board for digital output control.
12. Programming digital input devices such as switches and push buttons.
13. Sensor data acquisition and display using microcontroller.
14. Implementation of UART communication between two devices.
15. Implementation of I^2C communication with a sensor or peripheral.
16. Implementation of SPI communication with a sensor or display module.
17. Debugging and troubleshooting embedded software using serial monitor/debugging tools.
18. Integration of sensor, controller, and actuator modules into a complete system.
19. Functional testing of the integrated electronic product.
20. Performance testing under different operating conditions.
21. Calibration of sensor-based measurement system.
22. Fault identification and troubleshooting in integrated systems.
23. Preparation of product validation checklist and validation report.
24. Design of product enclosure using CAD tools or enclosure planning templates.
25. Preparation of Bill of Materials (BOM) and product cost estimation.
26. Preparation of user manual and technical documentation.
27. Preparation of product demonstration and presentation materials.
28. Mini Project Phase-I: Product Design and Prototype Development.
29. Mini Project Phase-II: Testing, Demonstration, and Final Presentation.

Text Books

1. Arshad Iqbal, Practical Electronics for Inventors, McGraw-Hill Education, ISBN-13: 978-1259587542, 4th Edition.
2. Simon Monk, Maker's Guide to the Zombie Apocalypse: Defend Your Base with Simple Circuits, Arduino, and Raspberry Pi, McGraw-Hill Education, ISBN-13: 978-0071834056, 1st Edition.
3. John Catsoulis, Designing Embedded Hardware, O'Reilly Media, ISBN-13: 978-0596007553, 2nd Edition. Reference Books

Reference Books:

1. Andrew N. Sloss, Dominic Symes, Chris Wright, *ARM System Developer's Guide: Designing and Optimizing System Software*, Morgan Kaufmann / Elsevier, ISBN-13: 978-1558608740, 1st Edition.
2. Frank Vahid, Tony Givargis, *Embedded System Design: A Unified Hardware/Software Introduction*, Wiley India, ISBN-13: 978-8126508372, 2nd Edition.
3. Tammy Noergaard, *Embedded Systems Architecture*, Newnes /Elsevier, ISBN-13: 978-0123821966, 2nd Edition.

NPTEL / SWAYAM Courses

1. NPTEL Course: **Embedded Systems: Introduction** by Prof. Santanu Chaudhary, IIT Delhi. https://nptel.ac.in/courses/108102045
2. NPTEL Course: **Introduction to Embedded System Design** by Prof. Dhananjay V. Gadre, IIT Jammu and Netaji Subhas University of Technology. https://nptel.ac.in/courses/108102169
3. NPTEL Course: **Embedded Systems Design** by Prof. Santanu Chattopadhyay, IIT Kharagpur. https://nptel.ac.in/courses/106105159
4. NPTEL Course: **Introduction to Embedded System Design** by Prof. Dhananjay V. Gadre, Netaji Subhas University of Technology. https://nptel.ac.in/courses/106105193

THIRD YEAR

SEMESTER VI

26AF1844PC601	Design and Analysis of Algorithms	03 Credits

Course Objectives:

The objective of this course is to provide students with

1. Explain fundamental algorithm design, analysis, and performance evaluation concepts using asymptotic notations and recurrence solving techniques.
2. Solve computational problems by applying algorithmic paradigms such as divide-and-conquer, greedy, dynamic programming, backtracking, and branch-and-bound.
3. Implement algorithms for searching, sorting, shortest path, matrix operations, and combinatorial optimization, and evaluate their time and space complexity.
4. Compare algorithmic strategies for problem-solving and justify the choice of technique based on efficiency and problem constraints.
5. Classify problems into complexity classes P, NP, and NP-complete, and apply polynomial-time reductions to analyse computational hardness.

Course Outcomes:

After completing this course, students will be able to:

CO1: Analyze the time and space complexity of algorithms using asymptotic notations, recurrence relations, and algorithm analysis techniques.

CO2: Apply divide-and-conquer techniques to design and evaluate efficient algorithms for searching, sorting, and matrix multiplication problems.

CO3: Solve combinatorial optimization problems using backtracking and branch-and-bound techniques.

CO4: Apply greedy algorithm design strategies to obtain efficient solutions for optimization and graph problems.

CO5: Develop dynamic programming solutions for optimization problems and differentiate computational complexity classes including P, NP, and NP-Complete problems.

Unit-I: Introduction to Algorithms **08 Hours**

Introduction to Algorithms: Definition, Properties of Algorithms, Expressing Algorithm, Flowchart, Algorithm Design Techniques, Performance Analysis of Algorithms, Types of Algorithms Analysis, Order of Growth, Asymptotic Notations, Recursion, Recurrences Relation, Substitution Method, Iterative Method, Recursion Tree, Master Theorem, Changing Variable, Heap Sort.

Unit-II: Divide and Conquer **08 Hours**

Introduction, Binary Search, Merge Sort, Quick Sort, Strassen‘s Matrix Multiplication.

Unit-III: Backtracking **08 Hours**

Backtracking Concept, N–Queens Problem, Four–Queens Problem, Eight–Queen Problem, Hamiltonian Cycle, Sum of Subsets Problem, Graph Coloring Problem, Branch and Bound: Introduction, Traveling Salesperson Problem, 15-Puzzle Problem, Comparisons between Backtracking and Branch and Bound.

Unit-IV: Greedy Algorithms **08 Hours**

Introduction to Greedy Technique, Greedy Method, Optimal Merge Patterns, Huffman Coding, Knapsack Problem, Activity Selection Problem, Job Sequencing with Deadline, Minimum Spanning Tree, Single-Source Shortest Path Algorithm.

Unit-V: Dynamic Programming **08 Hours**

Introduction, Characteristics of Dynamic Programming, Component of Dynamic Programming, Comparison of Divide-and-Conquer and Dynamic Programming Techniques, Longest Common Subsequence, matrix multiplication, shortest paths: Bellman-Ford, Floyd Warshall, Application of Dynamic Programming. **NP Completeness:** Introduction, the Complexity Class P, the Complexity Class NP, Polynomial-Time Reduction, the Complexity Class NP-Complete.

Text Books

1. T. Cormen, Introduction to Algorithms, PHI Publication, 4 th Edition, 2022.

Reference Books:

1. Aho, Ullman, Data Structure and Algorithms, Addison-Wesley Publication, 1 st Edition, 1983.
2. Michel Goodrich, Roberto Tamassia, Algorithm Design – Foundation, Analysis & Internet Examples, Wiley Publication, 2 nd Edition,2006.
3. George T. Heineman, Gary Pollice, Stanley Selkow, Algorithms in a Nutshell, A Practical Guide, O'Reilly Media, 2 nd Edition, 2016.
4. Ellise Horowitz, Sartaj Sahni, S. Rajasekaran, Fundamentals of Computer Algorithms, University Press (India) Private Ltd, 2 nd Edition, 2008.
5. Sara Base, Computer algorithms: Introduction to Design and Analysis, Addison-Wesley Publication, 2 nd Edition, 1988.

NPTEL / SWAYAM Courses

1. Introduction to Algorithms and Analysis, by Prof. Sourav Mukhopadhyay IIT Kharagpur https://nptel.ac.in/courses/106105164
2. Design and analysis of algorithms, Prof. Madhavan Mukund, Chennai Mathematical Institute https://nptel.ac.in/courses/106106131

26AF1844PC602L	Design and Analysis of Algorithms Lab	01 Credits

Course Objectives:

The objective of this course is to provide students with

1. Understand and implement fundamental algorithm design techniques such as divide-and-conquer, greedy, graph, and tree algorithms.
2. Develop programming skills for solving computational problems using efficient data structures and algorithms.
3. Analyze the correctness and efficiency of algorithms through practical implementation and execution.
4. Compare different searching, sorting, graph, and tree traversal algorithms based on their performance and applications.
5. Enhance problem-solving and logical reasoning skills by implementing classical algorithms for real-world computational problems.

Course Outcomes:

After completing this course, students will be able to:

CO1: Implement searching and sorting algorithms to solve computational problems efficiently.

CO2: Apply divide-and-conquer and greedy algorithmic techniques to optimize problem olving.

CO3: Develop graph-based algorithms for shortest path, minimum spanning tree, and graph traversal applications.

CO4: Implement tree and graph traversal algorithms using appropriate data structures.

CO5: Analyze and compare the performance and correctness of various algorithms based on time and space complexity.

List of Experiments:

1. Implementation of Binary Search.
2. Implementation of finding maximum and minimum numbers using divide and conquer.
3. Implementation of Merge / Quick sort.
4. Implementation of Selection sort.
5. Implementation of Job Sequencing with deadlines.
6. Program for finding the minimum cost Spanning Tree.
7. Implementation of single-source shortest path.
8. Implementation of all-pairs shortest path.
9. Program for Tree traversal techniques.
10. Program for Graph Traversal Technique.

26AF1844PC603	Internet of Things	03 Credits

Course Objectives:

The objective of this course is to:

1. Understand the fundamentals, architecture, and enabling technologies of the Internet of Things (IoT).
2. Learn IoT communication protocols, networking technologies, and device connectivity methods.
3. Explore cloud platforms, data acquisition, storage, and analytics for IoT applications.
4. Understand security, privacy, and device management techniques in IoT systems.
5. Design IoT-based solutions for smart home, industrial, agricultural, and healthcare applications.

Course Outcomes:

After completing this course, students will be able to:

CO1: Explain IoT architecture, enabling technologies, and communication models.

CO2: Analyze IoT networking technologies and communication protocols for connected devices.

CO3: Apply cloud platforms and data analytics techniques for IoT applications.

CO4: Evaluate IoT security mechanisms and privacy-preserving techniques for secure deployment.

CO5: Design IoT solutions for real-world applications using appropriate hardware, networking, and cloud technologies.

Unit-I: IoT Fundamentals and Architecture **08 Hours**

Introduction to Internet of Things, Characteristics and Evolution of IoT, IoT Ecosystem and Applications, IoT Architecture: Perception Layer, Network Layer, Middleware Layer, Edge Layer Application Layer; IoT Enabling Technologies: Embedded Systems, Communication Networks, Cloud Computing, Big Data; IoT Communication Models: Device-to-Device (D2D), Device-to-Cloud (D2C), Device-to-Gateway (D2G), Back-End Data Sharing

Unit-II: IoT Communication and Networking **08 Hours**

IoT Communication Protocols: MQTT, CoAP, HTTP, AMQP, WebSockets, Protocol Comparison: Data Rate, Power Consumption, Communication Range; IP Addressing Basics, DNS and NAT Concepts, IPv6 and IPv6 for IoT; Wireless Technologies: Wi-Fi, Bluetooth Low Energy (BLE), ZigBee, LoRa; Network Topologies, Mesh Networking

Unit-III: IoT Cloud Platforms and Data Analytics **08 Hours**

IoT Data Formats: JSON, XML; REST APIs, Sensor Cloud, IoT Cloud Platforms: Firebase ThingSpeak, Blynk, AWS IoT, Microsoft Azure IoT, Google Cloud IoT, ThingsBoard, Data Acquisition and Storage, Data Visualization, IoT Dashboards, Cloud-Based Data Analytics, Trend Analysis and Threshold Alerts

Unit-IV: IoT Security and Device Management **08 Hours**

IoT Security Challenges, Authentication and Authorization, Data Encryption Techniques, Secure Boot, Firmware Over-the-Air (FOTA) Updates, Hardware Security Modules (HSMs), Access Control, Data Privacy in IoT, Zero Trust Security, Lightweight Cryptography, Device Monitoring and Management

Unit-V: IoT Applications and Emerging Trends **08 Hours**

Smart Home Automation, Industrial Internet of Things (IIoT), Predictive Maintenance, Smart Agriculture using LoRa, Healthcare IoT, Smart City Applications, Wearable IoT Devices, Edge Computing in IoT, Green IoT and Energy-Efficient Design, Future Trends in IoT.

Text Books

1. Arshdeep Bahga, Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, ISBN-13: 978-8173719547, 1st Edition.
2. Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill Education, ISBN-13: 978-9353164966, 2nd Edition.
3. Srinivasa K. G., Siddesh G. M., Hanumantha Raju R., Internet of Things, Cengage Learning, ISBN-13: 978-9353501877, 1st Edition.

Reference Books:

1. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, Wiley, ISBN-13: 978-1119994350, 2nd Edition.
2. Hakima Chaouchi, The Internet of Things: Connecting Objects, Wiley-ISTE, ISBN-13: 978-1848211407, 1st Edition.
3. Jeeva Jose, Internet of Things, Khanna Publishing House, ISBN-13: 978-9386173737, 1st Edition.

NPTEL / SWAYAM Courses

1. Introduction to Internet of Things by Prof. Sudip Misra, IIT Kharagpur https://nptel.ac.in/courses/106105166
2. Introduction to Industry 4.0 and Industrial Internet of Things by Prof. Sudip Misra, IIT Kharagpur https://nptel.ac.in/courses/106105195

26AF1844PC604L	Internet of Things Lab	01 Credits

Course Objectives:

The objective of this course is to

1. Develop IoT applications using ESP32 and various sensors.
2. Implement IoT communication protocols and wireless networking for connected devices.
3. Integrate IoT devices with cloud platforms for remote monitoring and control.
4. Apply IoT security practices for secure data transmission and device management.
5. Design and implement end-to-end IoT solutions for real-world applications.

Course Outcomes:

After completing this course, students will be able to:

CO1: Configure ESP32 and interface sensors and actuators for IoT applications.

CO2: Implement wireless communication and IoT protocols for device connectivity.

CO3: Develop cloud-connected IoT applications for data acquisition and visualization.

CO4: Apply security techniques and remote device management in IoT systems.

CO5: Design and demonstrate complete IoT solutions for real-world applications.

List of Experiments: (Select any 10 Experiment from the list)

1. Publishing sensor (LDR/Temperature/Humidity) data using MQTT protocol.
2. Communication between ESP32 and cloud server using HTTP/REST API.
3. Bluetooth Low Energy (BLE) communication using ESP32.
4. Data exchange between two ESP32 boards over Wi-Fi.
5. Uploading sensor data to ThingSpeak cloud.
6. IoT dashboard development using Blynk.
7. Storing and retrieving sensor data using Firebase Realtime Database.
8. Visualization and trend analysis of sensor data on cloud dashboards.
9. Threshold-based notification using cloud platform.
10. Secure communication using HTTPS.
11. Authentication and API key management for cloud services.
12. Remote monitoring and control of IoT devices.
13. Firmware update concepts and OTA update demonstration.
14. Secure IoT device access using user authentication.
15. Mini Project: End-to-End IoT application integrating ESP32, sensors, cloud platform, dashboard, and remote monitoring.
    a. Smart Home Automation using ESP32 and Blynk.
    b. Smart Agriculture Monitoring System using soil moisture sensor.
    c. Industrial Parameter Monitoring using multiple sensors.
    d. Energy monitoring and smart switching application.

26AF1844PE605A	Deep Learning	03 Credits

Course Objectives:

The objective of this course is to:

1. Learn fundamental concepts of artificial neural network
2. Introduce neural network architecture and its training
3. Learn fundamental concepts of convolution neural network
4. Understand the Recurrent neural network

Course Outcomes:

After completing this course, students will be able to:

CO1: Illustrate fundamental concept of neural network.

CO2: Design neural network architecture to solve real world problem.

CO3: Evaluation the performance of neural network architecture.

CO4: Use convolution neural network to solve real world problems.

CO5: Develop practical solutions for real-world problems using RNNs.

Unit-I: Neural Networks **08 Hours**

Introduction to Neural Network, Biological neuron, Model of Artificial Neuron, Learning rules and activation functions: ReLU, Sigmoid, Softmax and others, Loss, function - L1, L2 – Function approximation, classification / clustering problems –Performance parameters for classification and regression, Applications

Unit-II: Neural Network Architecture **08 Hours**

Single layer Feed-forward networks. Multilayer Feed-forward networks, forward propagation, Back Propagation networks, Architecture of Back-propagation (BP) Networks, Backpropagation Learning, Learning the weights, Chain rule, Stochastic gradient descent, Sigmoid units, and vanishing gradient

Unit-III: Effective training in Deep Neural Network **08 Hours**

Early stopping, Dropout, Batch Normalization, Instance Normalization, Group Normalization, Minibatch gradient descent, Data Augmentation, Stratification, Generalization Gap – Under-fitting Vs Over-fitting, Optimization: Momentum, Learning rate schedules, AdaGrad, RMSProp and Adam optimization, and Batch Normalization, Initialization – weights, Bias

Unit-IV: Convolution Neural Network **08 Hours**

Basic structure of Convolutional Network, Convolutions for Images, Padding and Stride, Multiple Input and Multiple Output Channels, Pooling, FCNN, Advanced Architectures: VGG16/19, AlexNet, ResNet, and others, Transfer learning, CNN for Image Classification.

Unit-IV: Recurrent Neural Network **08 Hours**

Introduction, architecture, training in RNN, variants of RNN: LSTM, GRU, Bidirectional RNN, applications

Text Books

1. Ian Goodfellow Yoshua Bengio Aaron Courville , Deep Learning, , MIT Press, 2017
2. Michael Nielsen, Neural Networks and Deep Learning, , Determination Press
3. Aggarwal, Charu C. Neural networks and deep learning. Vol. 10. No. 978. Springer, 2018.

Reference Books:

1. Jacek M. Zurada,"Introduction to artificial neural systems", West Publishing Co., 1992, ISBN: 0-3 14-93391 - 3.
2. Bishop C. M., "Pattern Recognition and Machine Learning", Springer, 2006, ISBN: 978-0-387-31073-2
3. Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks, Umberto Michelucci, Apress, 2018.
4. Deep Learning with Python", Francois Chollet, Manning Publications, 2017.

NPTEL / SWAYAM Courses

1. Deep Learning - IIT Ropar, Prof. Sudarshan Iyengar, IIT Ropar https://nptel.ac.in/courses/106106
2. Deep Learning, Prof. Prabir Kumar Biswas, IIT Kharagpur https://nptel.ac.in/courses/106105215

26AF1844PE605B	Network Security and Ethical Hacking	03 Credits

Course Objectives:

The objective of this course is to:

1. Understand network security architecture, protocols, and secure communication mechanisms.
2. Learn ethical hacking methodologies, penetration testing techniques, and vulnerability assessment.
3. Analyze network attacks, exploits, and corresponding defense strategies.
4. Gain practical knowledge of security tools used for network monitoring and ethical hacking.
5. Develop the ability to assess, secure, and harden enterprise network infrastructures

Course Outcomes:

After completing this course, students will be able to:

CO1: Explain network security concepts, architectures, and secure communication protocols.

CO2: Analyze network vulnerabilities, attacks, and exploitation techniques.

CO3: Apply ethical hacking methodologies and penetration testing tools to identify security weaknesses.

CO4: Evaluate network security mechanisms, firewalls, IDS/IPS, VPNs, and wireless security solutions.

CO5: Recommend appropriate security controls and mitigation strategies for enterprise networks.

Unit-I: Introduction to Network Security **08 Hours**

Introduction to Network Security, Security Models and Architecture, TCP/IP Security, Common Network Protocols and Vulnerabilities, Network Threat Landscape, Attack Surface Analysis, Security Policies, Network Segmentation, Defense-in-Depth Strategy

Unit-II: Network Attacks and Vulnerability Assessment **08 Hours**

Reconnaissance Techniques, Footprinting and Enumeration, Scanning Networks using Nmap, Vulnerability Assessment Concepts, OpenVAS and Nessus Overview, Password Attacks, Sniffing and Spoofing, Denial-of-Service (DoS/DDoS) Attacks, Social Engineering Basics.

Unit-III: Ethical Hacking and Penetration Testing **08 Hours**

Ethical Hacking Methodology, Penetration Testing Phases, Exploitation Techniques, Metasploit Framework, Web Application Security Basics, SQL Injection, Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), Secure Penetration Testing Practices.

Unit-IV: Network Defense Technologies **08 Hours**

Firewalls and Firewall Architectures, Intrusion Detection and Prevention Systems (IDS/IPS), Virtual Private Networks (VPN), Secure Routing, Wireless Network Security (WPA2/WPA3), Email Security, DNS Security, Network Access Control (NAC), Zero Trust Networking.

Unit-IV: Enterprise Network Security **08 Hours**

Security Monitoring and Logging, Security Information and Event Management (SIEM) Overview, Incident Handling Basics, Cloud Network Security, Software Defined Network (SDN) Security, IoT Security Challenges, Security Best Practices.

Text Books

1. William Stallings, Cryptography and Network Security: Principles and Practice, Pearson Education, ISBN-13: 978-9353943837, 8th Edition.
2. Michael T. Simpson, Kent Backman, James Corley, Hands-On Ethical Hacking and Network Defense, Cengage Learning, ISBN-13: 978-1337405775, 4th Edition.
3. Rafay Baloch, Ethical Hacking and Penetration Testing Guide, CRC Press, ISBN-13: 978-1482231618, 2nd Edition.

Reference Books:

1. Charlie Scott, Network Security Fundamentals, Cisco Press.
2. Jon Erickson, Hacking: The Art of Exploitation, No Starch Press, 2nd Edition.
3. Georgia Weidman, Penetration Testing: A Hands-On Introduction to Hacking, No Starch Press.

NPTEL / SWAYAM Courses

1. Ethical Hacking, Prof. Indranil Sengupta, IIT Kharagpur
   https://nptel.ac.in/courses/106105217
2. Cyber Security and Privacy, Prof. Saji K Mathew, IIT Madras
   https://nptel.ac.in/courses/106106248

26AF1844PE605C	Digital IC Design using Verilog HDL	03 Credits

Course Objectives:

The objective of this course is to:

1. Understand the RTL design methodology using Verilog HDL.
2. Design combinational and sequential digital circuits using Verilog.
3. Apply finite state machine (FSM) concepts to digital system design.
4. Implement and verify digital designs using FPGA development tools.
5. Analyze timing, synthesis, and optimization of digital ICs.

Course Outcomes:

After completing this course, students will be able to:

CO1: Explain Verilog HDL syntax and digital design methodology.

CO2: Design combinational and sequential digital circuits using Verilog HDL.

CO3: Develop finite state machine-based digital systems.

CO4: Analyze synthesized digital circuits for timing and resource utilization.

CO5: Implement and verify digital designs on FPGA platforms.

Unit-I Introduction to Digital IC Design and Verilog **08 Hours**

Digital IC design flow, ASIC vs FPGA, RTL Design Methodology, Introduction to Verilog HDL, Lexical conventions, Data types, Operators, Numbers and constants, Modules and ports, Structural modeling, Dataflow modeling, Behavioral modeling, Test-bench fundamentals.

Unit-II: Combinational Logic Design using Verilog **08 Hours**

Continuous assignment, Procedural assignment, Combinational circuit modeling, Multiplexers, Demultiplexers, Encoders, Decoders, Comparators, Adders and subtractors, Arithmetic Logic Unit (ALU), Barrel shifter, Code converters, Verification using test-bench.

Unit-III: Sequential Circuit Design using Verilog **08 Hours**

Latches, Flip-Flops, Registers, Shift registers, Counters, Synchronous counters, Asynchronous counters, Memory modeling, Parameterized modules, Generate statements, Sequential design verification using Test-bench.

Unit-IV: Finite State Machine (FSM) Design and FPGA Implementation **08 Hours**

Mealy FSM, Moore FSM, State diagrams, State encoding, FSM implementation, Traffic light controller, Vending machine controller, UART controller, Elevator controller, FPGA design flow, Pin assignment, Bitstream generation.

Unit-V: Synthesis and Timing Analysis **08 Hours**

RTL synthesis, Logic optimization, Resource utilization, Timing constraints, Static Timing Analysis (STA), Setup time, Hold time, Clock skew, Timing closure, FPGA implementation, Introduction to ASIC synthesis

Text Books

1. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Pearson India, 2nd Edition. 2003
2. M. Morris Mano and Michael D. Ciletti, Digital Design, Pearson Publication, 6th Edition.

3. Pong P. Chu, FPGA Prototyping by Verilog Examples, Wiley Publication.

Reference Books:

1. Stephen Brown and Zvonko Vranesic, Fundamentals of Digital Logic with Verilog Design, McGraw Hill Education, Mc Graw Hill Publication, Evergreen Release, 2025.
2. J. Bhasker, A Verilog® HDL Primer, Pearson Education, BSP Books, 3rd Edition.
3. Pedroni, Volnei A., Circuit Design with VHDL, MIT Press, 2020.

NPTEL / SWAYAM Courses

1. Digital System design with PLDs and FPGAs, Prof. Kuruvilla Varghese, IISc Bangalore, https://nptel.ac.in/courses/117108040
2. VLSI Design Flow: RTL to GDS, Prof. Sneh Saurabh, IIT Delhi. https://nptel.ac.in/courses/108106191
3. Digital Design with Verilog, Prof. Chandan Karfa, Prof. Aryabartta Sahu, IIT Guwahati, https://nptel.ac.in/courses/106103358

26AF1844PE607A	Natural Language Processing	03 Credits

Course Objectives:

The objective of this course is to:

1. Understand the fundamental concepts, architecture, challenges, and preprocessing techniques used in Natural Language Processing.
2. Explain the principles of speech and language processing, including speech recognition, synthesis, and their practical applications.
3. Analyze text using parsing, information extraction, text classification, and sentiment analysis techniques.
4. Interpret lexical semantics, language understanding, multilingual NLP, and machine translation concepts.
5. Evaluate modern NLP applications along with ethical, privacy, fairness, and responsible AI considerations in real-world systems.

Course Outcomes:

After completing this course, students will be able to:

CO1: Explain the fundamentals of Natural Language Processing, text preprocessing, language models, and Indian language processing.

CO2: Describe speech and language processing techniques, including speech recognition, text-to-speech, speech-to-text, and their applications.

CO3: Analyze textual data using parsing, information extraction, named entity recognition, text classification, and sentiment analysis techniques.

CO4: Interpret lexical semantics, word relationships, word sense disambiguation, multilingual NLP, and machine translation concepts.

CO5: Evaluate NLP-based intelligent applications while addressing ethical issues, bias, fairness, privacy, and responsible AI practices.

Unit-I: Introduction to Natural Language Processing **08 Hours**

Introduction, Applications of NLP, Challenges in Natural Language Processing, Text Processing Basics, Tokens, Words and Sentences, Morphology (basic concepts), Parts of Speech (POS) Tagging, Introduction to Language Models (N-grams – overview), Overview of Indian Language Processing.

Unit-II: Speech and Language Processing **08 Hours**

Introduction, Speech Recognition (basic concepts), Text-to-Speech (TTS), Speech-to-Text (STT), Components of a Speech Processing System, Applications of Speech Technologies in Virtual Assistants, Education, Healthcare, and Accessibility.

Unit-III: Text Analysis and Information Extraction **08 Hours**

Introduction to Parsing (concept), Syntactic and Semantic Analysis (overview), Named Entity Recognition (NER), Dependency Parsing (basic concept), Information Extraction, Text Classification, Introduction to Sentiment Analysis

Unit-IV: Lexical Semantics and Language Understanding **08 Hours**

Introduction, WordNet (basic concepts), Semantic Relationships (Synonym, Antonym, Hypernym, Hyponym), Word Sense Disambiguation (overview), Coreference Resolution (basic concept), Multilingual NLP (overview), Machine Translation (introduction).

Unit-V: NLP Applications and Responsible AI **08 Hours**

Question Answering Systems, Information Retrieval, Chatbots and Conversational AI, Text Summarization (overview), Cross-Lingual Applications (overview), Ethical Issues in NLP, Bias and Fairness in Language Models, Privacy in Language Processing, Industrial Applications of NLP in Healthcare, Finance, Education, E-Commerce, and Smart Services.

Text Books

1. Jurafsky Daniel, Martin James, "Speech and Language Processing", Second Edition, Tenth Impression, Pearson Education, 2018.
2. Christopher Manning, Schutze Heinrich, "Foundations of Statistical Natural Language Processing", MIT Press, 1999.
3. Allen James, "Natural Language Understanding", Second Edition, Benjamin Cumming, 1995.

Reference Books:

1. Charniack Eugene, "Statistical Language Learning", MIT Press, 1993.
2. Foundations of Statistical Natural Language Processing, The MIT Press Cambridge, Massachusetts London, England,1999.
3. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana, "Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems", O'REILLY, 2020

NPTEL / SWAYAM Courses

1. Natural Language Processing, Prof. Pawan Goyal, IIT Kharagpur. https://nptel.ac.in/courses/106105158
2. Deep Learning for Natural Language Processing, Prof. Pawan Goyal, IIT Kharagpur, https://nptel.ac.in/courses/108105572

26AF1844PE607B	Modern Communication Systems	03 Credits

Course Objectives:

The objective of this course is to:

1. Understand the fundamentals of modern communication systems.
2. Learn basic analog and digital communication techniques.
3. Explore wireless communication technologies and standards.
4. Understand communication networks and multiple access methods.
5. Familiarize with emerging communication technologies and applications.

Course Outcomes:

After completing this course, students will be able to:

CO1: Explain the fundamentals and applications of modern communication systems.

CO2: Compare analog and digital communication techniques.

CO3: Apply wireless communication concepts in practical applications.

CO4: Analyze communication networks and multiple access techniques.

CO5: Describe emerging communication technologies and future trends.

Unit-I: Introduction to Communication Systems **08 Hours**

Evolution of Communication Systems, Elements of Communication Systems: Information Source, Transmitter, Channel, Receiver, Destination; Analog and Digital Signals, Communication Channels: Wired, Wireless; Noise and Interference, Applications of Modern Communication Systems

Unit-II: Basics of Analog and Digital Communication **08 Hours**

Need for Modulation, Basic Concepts of: Amplitude Modulation (AM), Frequency Modulation (FM), Sampling and Quantization Concepts, Pulse Code Modulation (PCM), Introduction to Digital Modulation: ASK, FSK, PSK; Analog vs Digital Communication

Note: Mathematical derivations are excluded.

Unit-III: Wireless Communication **08 Hours**

Need for Wireless Communication, Advantages and Challenges of Wireless Systems, Wireless Communication Architecture, Radio Frequency Spectrum Overview; Concept of Cellular Communication: Cell, Cluster, and Frequency Reuse, Evolution of Mobile Communication: 1G, 2G, 3G, 4G, 5G (Comparison only), Satellite Communication System overview.

Unit-IV: Communication Technologies **08 Hours**

Features, Architecture and applications of: Wi-Fi, Bluetooth and Bluetooth Low Energy (BLE), ZigBee, LoRa and LPWAN Technologies, Wireless Sensor Networks (WSN), Comparison of Wireless Technologies

Unit-V: Communication Networks **08 Hours**

Introduction to Communication Networks: Types of Networks: PAN, LAN, MAN, WAN, Multiplexing Techniques: FDM, TDM, Applications of Multiplexing, Multiple Access Techniques: FDMA, TDMA, CDMA and OFDMA, Applications of Communication Networks

Text Books

1. Simon Haykin, Michael Moher, An Introduction to Analog and Digital Communications, Wiley India, ISBN-13: 978-8126529544, 2nd Edition.
2. B. P. Lathi, Zhi Ding, Modern Digital and Analog Communication Systems, Oxford University Press, ISBN-13: 978-0198073802, 4th Edition.
3. Rappaport Theodore S., Wireless Communications: Principles and Practice, Pearson Education, ISBN-13: 978-9332551748, 2nd Edition.

Reference Books:

1. George Kennedy, Bernard Davis, Electronic Communication Systems, McGraw Hill Education, ISBN-13: 978-0071077828, 5th Edition.
2. William Stallings, Wireless Communications and Networks, Pearson Education, ISBN-13: 978-8131720929, 2nd Edition.
3. Jochen Schiller, Mobile Communications, Pearson Education, ISBN-13: 978-8131724262, 2nd Edition.
4. Andreas F. Molisch, Wireless Communications, Wiley India, ISBN-13: 978-8126541911, 3rd Edition.

NPTEL / SWAYAM Courses

1. **Analog Communication** by Prof. Aditya K. Jagannatham, IIT Kanpur. https://nptel.ac.in/courses/108104091
2. **Wireless Communication** by Prof. Aditya K. Jagannatham, IIT Kanpur. https://nptel.ac.in/courses/108104113

26AF1844PE607C	Full Stack Development	03 Credits

Course Objectives:

The objective of this course is to provide students with

1. Understand the architecture and components of full stack web application development.
2. Design responsive user interfaces using HTML, CSS, Bootstrap, and JavaScript.
3. Develop server-side applications and RESTful APIs using Node.js and Express.js.
4. Implement database operations using MongoDB and integrate frontend with backend.
5. Deploy full stack web applications using modern cloud platforms and version control tools.

Course Outcomes:

After completing this course, students will be able to:

CO1: Explain the architecture and workflow of full stack web applications.

CO2: Develop responsive and interactive web pages using frontend technologies.

CO3: Build backend applications and RESTful APIs using Node.js and Express.js.

CO4: Integrate MongoDB database with web applications for CRUD operations.

CO5: Deploy and manage full stack applications using GitHub and cloud hosting platforms.

Unit-I: Introduction to Full Stack Development **08 Hours**

Overview of Web Technologies, Client-Server Architecture, Three-Tier Architecture, Frontend, Backend and Database Concepts, Introduction to HTTP and HTTPS, Web Browsers and Developer Tools, Introduction to Git and GitHub, Setting up Development Environment, Visual Studio Code, Node.js and npm Installation, Creating First Web Application

Unit-II: Frontend Development **08 Hours**

HTML5 Fundamentals, Forms and Input Controls, CSS3 Styling, Flexbox and Grid Layout, Responsive Web Design, Bootstrap Framework, JavaScript Basics, DOM Manipulation, Event Handling, ES6 Features, Form Validation.

Unit-III: Backend Development using Node.js **08 Hours**

Introduction to Node.js, npm Package Manager, Express.js Framework, Routing, Middleware, Types of API, REST API Development, Request and Response Handling, Error Handling, JSON Data Exchange, Testing APIs using Postman

Unit-IV: Database Integration **08 Hours**

Introduction to NoSQL Database, MongoDB Fundamentals, MongoDB Collections and Documents, CRUD Operations, Mongoose ODM, Database Connectivity, User Authentication Basics, Password Encryption, Session Management, Connecting Frontend with Backend.

Unit-V: Full Stack Application Deployment **08 Hours**

Project Structure, MVC Architecture, Environment Variables, Git Version Control, GitHub Repository Management, Application Deployment, Cloud Platforms (Render/Vercel/Netlify), Debugging Techniques, Testing and Performance Optimization, Mini Project Demonstration

Text Books

1. Chris Northwood, The Full Stack Developer: Your Essential Guide to the Everyday Skills Expected of a Modern Full Stack Web Developer, Apress, 2023.
2. Ethan Brown, Web Development with Node and Express, O'Reilly Media, 3rd Edition, 2024.
3. Jon Duckett, HTML and CSS: Design and Build Websites, Wiley, 2nd Edition.

Reference Books:

1. Brad Dayley, Brendan Dayley, Caleb Dayley, Node.js, MongoDB and Angular Web Development, Addison-Wesley.
2. David Flanagan, JavaScript: The Definitive Guide, O'Reilly Media, 7th Edition.
3. Stoyan Stefanov, React Up & Running, O'Reilly Media

NPTEL / SWAYAM Courses

1. Introduction to Modern Application Development, Prof. Gaurav Raina, Tanmai Gopal, IIT Madras, https://nptel.ac.in/courses/106106156
2. Programming in Java – Prof. Debasis Samanta, IIT Kharagpur https://nptel.ac.in/courses/106105191
3. Introduction to Database Systems and Design, Prof. P.Sreenivasa Kumar, IIT Madras https://nptel.ac.in/courses/106106095

26AF1844PC608	Computer Networks	03 Credits

Course Objectives:

The objective of this course is to provide students with

1. Understand the fundamental concepts, architectures, and protocols of computer networks and their applications.
2. Analyze the functions and operation of Data Link and Network Layer protocols used in modern communication systems.
3. Examine Transport and Application Layer protocols for reliable end-to-end communication and network services.
4. Understand network security mechanisms, management techniques, and quality of service requirements in computer networks.
5. Apply network programming concepts and explore emerging networking technologies such as IoT, SDN, and 5G networks.

Course Outcomes:

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

CO1: Explain the fundamentals of computer networks, reference models, transmission media, and networking standards.

CO2: Analyze Data Link Layer protocols, error control mechanisms, medium access techniques, and Ethernet/Wireless LAN operations.

CO3: Apply IP addressing, subnetting, routing concepts, and network layer protocols to solve networking problems.

CO4: Analyze the operation of TCP/IP transport protocols and application layer services such as DNS, HTTP, FTP, and DHCP.

CO5: Apply network security principles, network management tools, and socket programming concepts to design basic network applications and evaluate emerging networking technologies.

Unit-I: Physical Layer **08 Hours**

Introduction to Computer Networks, Uses and Applications of Computer Networks, Types of Networks (PAN, LAN, MAN, WAN), Network Topologies, Network Categories, Network Protocols, OSI Reference Model, TCP/IP Reference Model, Comparison of OSI and TCP/IP Models, Transmission Media: Guided and Unguided, Standardization in Networking, Social and Legal Issues in Computer Networks.

Unit-II: The Data Link Layer **08 Hours**

Data Link Layer Functions and Services, Framing, Error Detection and Error Control, Elementary Data Link Protocols, Stop-and-Wait Protocol, Sliding Window Protocol, Go-Back-N and Selective Repeat ARQ, Multiple Access Protocols, MAC Sublayer, Ethernet (IEEE 802.3), Wireless LANs (IEEE 802.11), Switching Techniques.

Unit-III: Network Layer **08 Hours**

Network Layer Functions, Logical Addressing, IPv4 Addressing and Subnetting, IPv6 Addressing, IPv4 and IPv6 Header Formats, Internet Protocol (IP), ICMP Protocol, Routing Concepts, Routing Algorithms, Router Architecture, Introduction to Software Defined Networking (SDN).

Unit-IV: Transport and Application Layers **08 Hours**

Transport Layer Services, UDP and TCP Protocols, Reliable Data Transfer, Flow Control and

Congestion Control, DNS, HTTP and HTTPS, FTP, DHCP, Telnet and SSH, Electronic Mail Services, Multimedia Applications and Content Delivery.

Unit-V: Network Security, Management and Programming **08 Hours**

Introduction to Network Security, Security Threats and Vulnerabilities, Cryptography Fundamentals, Firewalls, Intrusion Detection Systems (IDS), Virtual Private Networks (VPNs), Authentication and Access Control, Network Monitoring and Management, SNMP, Quality of Service (QoS), Introduction to Socket Programming, Client-Server Architecture, TCP and UDP Socket Programming Concepts, Network Simulation using Packet Tracer, Internet of Things (IoT) Networking and 5G Networks.

Text Books

1. Behrouz A. Forouzan, Data Communications and Networking, McGraw Hill Education, ISBN-13: 978-1259064753, 5th Edition.
2. Andrew S. Tanenbaum, David J. Wetherall, Computer Networks, Pearson Education, ISBN-13: 978-0132126953, 5th Edition.
3. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, Pearson Education, ISBN-13: 978-9332585491, 7th Edition.

Reference Books

1. William A. Shay, Understanding Communications and Networks, Cengage Learning, ISBN-13: 978-8131505250, 3rd Edition.
2. Natalia Olifer, Victor Olifer, Computer Networks: Principles, Technologies and Protocols for Network Design, Wiley India, ISBN-13: 978-8126509171, 1st Edition.
3. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Morgan Kaufmann, ISBN-13: 978-0128182000, 6th Edition.

NPTEL Courses:

1. Computer Network and Internet Protocol by: Prof. Soumya Kanti Ghosh, Prof. Sandip Chakraborty, IIT Kharagpur, https://nptel.ac.in/courses/106105183
2. Computer Networks, Prof. Hema A Murthy, IIT Madras, https://nptel.ac.in/courses/106106091
3. Computer Networks, Prof. Ajit Pal, IIT Kharagpur, https://nptel.ac.in/courses/106105080

26AF1844PC609L	Computer Networks Lab	01 Credits

Course Objectives:

The objective of this course is to provide students with

1. Familiarize students with networking devices, network topologies, and communication media.
2. Develop skills in IP addressing, subnetting, routing, and network configuration.
3. Enable students to analyze network protocols and traffic using network monitoring tools.
4. Provide hands-on experience in network programming using TCP and UDP sockets.
5. Develop the ability to design, simulate, troubleshoot, and secure computer networks using industry-standard tools.

Course Outcomes:

After completing this course, students will be able to

CO1: Configure network devices and implement various network topologies for data communication.

CO2: Apply IP addressing, subnetting, and routing techniques in network design and configuration.

CO3: Analyze network protocols and traffic using packet analysis and monitoring tools.

CO4: Develop client-server applications using TCP and UDP socket programming.

CO5: Design, simulate, troubleshoot, and secure computer networks using networking tools and simulation software.

List of Experiments: (Select min 10 experiments and distributed unitwise)

1. Study and identification of networking devices and transmission media.
2. Design and implementation of different network topologies using Packet Tracer.
3. Simulation of Ethernet LAN and verification of frame transmission.
4. Study of MAC addressing and ARP operation using network tools.
5. IPv4 address configuration and connectivity verification using ping and traceroute.
6. Subnetting and CIDR-based network design for a given organization.
7. Static routing configuration using Cisco Packet Tracer.
8. Dynamic routing using RIP/OSPF protocols.
9. Analysis of TCP and UDP packets using Wireshark.
10. Study of DNS, HTTP, FTP, and DHCP protocols using packet capture tools.
11. Client-server communication using TCP socket programming.
12. Client-server communication using UDP socket programming.
13. Configuration of Access Control Lists (ACLs) and firewall rules in a simulated environment.
14. Study and analysis of network traffic and performance using Wireshark/SNMP tools.
15. Implementation of secure remote access using SSH and comparison with Telnet.
16. Simulation of Wireless LAN using Cisco Packet Tracer.
17. Network performance evaluation using NS-3/Packet Tracer.
18. Mini Project: Design and simulation of a small enterprise network with routing, security, and application services.