PONDICHERRY UNIVERSITY

(A CENTRAL UNIVERSITY)

REGULATIONS, CURRICULUM, & SYLLABUS

FOR

FOUR-YEAR UG DEGREE PROGRAMME IN

AUTONOMOUS VEHICLES AND SYSTEMS

(B.Sc. HONOURS)

(Under the National Education Policy 2020)

(For Affiliated Colleges of Pondicherry University)

Effective from the Academic Year (2024 - 2025)

PUDUCHERRY

JUNE 2024

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1. OBJECTIVE OF THE PROGRAMME

A programme on autonomous vehicles and systems aims to provide students with a comprehensive understanding of the principles, technologies, and challenges related to the design, development, and deployment of autonomous vehicles and robotic systems. Here are some specific aims of such a course:

I. **Understanding Autonomous Systems**: Provide students with a deep understanding of autonomous systems, including their definition, components, and the principles behind their operation. This includes both ground-based and aerial autonomous vehicles.

II. **Technological Foundations**: Introduce students to the technological foundations of autonomous systems, including sensors (such as LiDAR, radar, cameras, and ultrasonic sensors), actuators, control systems, and onboard processing units (such as microcontrollers and GPUs).

III. **Sensor Fusion and Perception**: Teach students about sensor fusion techniques and perception algorithms used to interpret sensor data and extract meaningful information about the environment. This includes topics such as object detection, tracking, localization, and mapping.

IV. **Decision Making and Control**: Cover algorithms and techniques for decision-making and control in autonomous systems. This includes path planning, motion planning, trajectory optimization, and reactive control strategies to navigate safely and efficiently in complex environments.

V. **Machine Learning and AI**: Introduce students to machine learning and artificial intelligence techniques used in autonomous systems, such as deep learning for perception tasks, reinforcement learning for decision-making, and probabilistic methods for uncertainty estimation.

VI. **Safety and Reliability**: Emphasize the importance of safety and reliability in autonomous systems design. Teach students about fail-safe mechanisms, redundancy, Fault Detection and Isolation (FDI), and risk assessment techniques to ensure the safe operation of autonomous vehicles.

VII. **Ethical and Legal Considerations**: Discuss ethical and legal considerations surrounding autonomous vehicles, including issues related to liability, privacy, cybersecurity, and societal impact. Encourage students to critically evaluate the ethical implications of autonomous systems deployment.

VIII. **Integration and Testing**: Provide hands-on experience with integrating hardware and software components to build functional autonomous systems. Teach students about testing methodologies, simulation techniques, and validation procedures to verify the performance and robustness of autonomous systems.

IX. **Industry Trends and Applications**: Explore current industry trends, research advancements, and real-world applications of autonomous vehicles and systems across various domains, such as transportation, logistics, agriculture, healthcare, and defence.

X. **Interdisciplinary Perspective**: Foster an interdisciplinary approach by integrating concepts from fields such as robotics, computer science, electrical engineering, mechanical engineering, and control theory to address the multifaceted challenges of autonomous systems.

Overall, the aim of a programme on autonomous vehicles and systems is to prepare students for careers in the rapidly evolving field of autonomous technology, equipping them with the knowledge, skills, and mindset necessary to innovate and contribute to the development of autonomous vehicles and robotic systems.

2. PROGRAMME OUTCOMES

Upon completion of the Bachelor of Science (B.Sc.) programme in Autonomous Vehicles and Systems, students will demonstrate the following outcomes at:

UG Certificate Level

- Demonstrate basic skills in problem-solving and programming.
- Communication and presentation skills
- Acquire foundational knowledge in electronics and basic science.

UG Diploma Level

- Develop intermediate-level knowledge and skills in robotics and electronics.
- Apply problem-solving and programming concepts to practical scenarios.
- Earn intermediate-level knowledge and skills in materials and engineering workshops.
- Learn intermediate-level knowledge and skills in 3D designing.

UG Degree Level

- Attain advanced knowledge and skills in Robotics and automation.
- Demonstrate proficiency in problem-solving, programming, and system design.
- Attain knowledge and skills in AI and IoT.

- Demonstrate proficiency in manufacturing Processes and control systems.

UG Degree with Honors

- Demonstrate proficiency in programming languages and software development.
- Apply principles of data structures and algorithms to solve complex problems.
- Design and implement efficient solutions for real-world automation challenges.
- Exhibit effective communication skills in conveying technical concepts verbally and in writing.
- Engage in collaborative projects and demonstrate the ability to work effectively in a team.
- Apply ethical considerations in professional and societal contexts related to computer science.
- Possess a comprehensive understanding of their specialization in automation of vehicles and industrial machines/ AI & ML / DS / Drones/ Designing/ Rapid Prototyping.
- Exhibit a commitment to lifelong learning and adaptability to evolving technologies.

3. DEFINITIONS

Terms used in the NEP Regulations shall have the meaning assigned to them as given below unless the context otherwise requires:

A. Credit: A credit is the number of hours of instruction required per week for the given subject in a given semester of 16-18 weeks. One credit is equivalent to 15 hours of teaching (lecture or tutorial) or 30 hours of practice or field work or community engagement and service per Semester.

B. Academic Year: Means the year starting on 1st day of July and ends on the 30th day of June succeeding year.

C. Residence time: Means the time a student spends for attending classes in the College/Institution (either Online/Offline) as a full-time student and enrolled in any Academic programme of the Institution.

D. Semester: Means 18 weeks (90 Working days) of the teaching-learning session of which two weeks shall be set apart for examinations and evaluation.

E. Grade: Means a letter grade assigned to a student in a course for his/her performance at academic sessions as denoted in symbols of: O (Outstanding), A+ (Excellent), A (Very good), B+ (Good), B (Above average), C (Average), P (Pass), F (Fail) and Ab (Absent) with a numeric value of O=10, A+=9, A=8, B+=7, B=6, C=5, P=4, and F=0, Ab=0.

F. Grade Point Average (GPA): Means an average of the Grades secured by a student in all courses in a given academic session duly weighted by the number of credits associated to each of the courses.

G. Cumulative GPA (CGPA): Means the weighted average of all courses the student has taken in the entire programme of study.

H. Common courses: Means the set of courses that all students who are admitted are required to study; these courses include, Languages (English- Modern Indian languages), NEP specific

courses viz. Understanding India, Environmental sciences/Education, Health and wellbeing/Yoga, and Digital & Technological solutions.

I. Major Discipline Courses: Means the core subjects mandatory for the Autonomous Vehicles and Systems discipline. These courses are common across all specializations of Autonomous Vehicles and Systems.

J. Minor Discipline Courses: Means allied/elective/specialization-specific subjects of Autonomous Vehicles and Systems discipline. Based on the set of Minor Discipline Courses the candidate study, specialization in Autonomous Vehicles and Systems will be awarded. e.g. B.Sc. (Autonomous Vehicles and Systems) with minor discipline courses in Artificial Intelligence and Machine Learning will be awarded B.Sc. Autonomous Vehicles and Systems with Specialization in Artificial Intelligence and Machine Learning.

K. Credit Requirements: For a Degree/Diploma/Certificate Programme means the minimum number of credits that a student shall accumulate to achieve the status of being qualified to receive the said Degree, Diploma/Certificate as the case may be.

L. Exit option: Means the option exercised by the student, to leave the Programme at the end of any given Academic year.

M. Lateral entry: Means a student being admitted into an ongoing Programme of the University otherwise than in the 1st year of the programme.

N. Vocational Studies/Education: Means set of activities for participation in an approved project or practical or lab, practices of application of scientific theories, studio activities involving students in creative artistic activities, workshop-based activities, field-based shop-floor learning, and Community engagement services, etc. **(These courses are expected to enable students to incorporate the learned skills in daily life and start-up entrepreneurship.)**

O. Skill-based learning/project: Means activities designed to understand the different socio-economic contexts, and first-hand understanding of the policies, regulations, organizational structures, processes, and programmes that guide the development process.

P. Work-based internship: Means structured internships with Software Companies, Research and Higher Educational Institution Laboratories, Corporate offices, etc. which will further improve employability.

4. DURATION OF THE PROGRAMME

The duration of the UG programme is 4 years or 8 semesters. Students who desire to undergo a 3-year UG Programme will be allowed to exit after completion of the 3rd year. If a student wants to leave after the completion of the first or second year, the student will be given a UG Certificate or UG Diploma, respectively, provided they secure the prescribed number of credits (as given in table below). Students who exit with a UG certificate or UG diploma are permitted to re-enter within three years and complete the degree programme. Students may be permitted to take a break from the study, they are allowed to reenter the degree programme within 3 years and complete the programme within the stipulated maximum period of seven years.

5. AWARD OF UG DEGREE/ DIPLOMA/ CERTIFICATE

Four years B.Sc. Degree Programme shall have options for earning a Certificate/ Diploma/ UG

Degree/ UG Degree with Honors based on the exit option exercised by the candidates.

5.1 Degree and Nomenclature

Candidates who complete Eight semesters and earn a minimum of 173 credits will be awarded either of the following degrees after successful completion of the other requirements.

- B.Sc. Autonomous Vehicles and Systems (Honors with Research) *
- B.Sc. Autonomous Vehicles and Systems (Honors) **

* For candidates who complete a research project work in the Eighth Semester

** for candidates who complete 3 theory courses instead of the research project work in the Eighth Semester

3-year UG Degree: Students who wish to discontinue after the 3-year UG will be awarded a UG Degree in the Major discipline after successful completion of three years, earning a minimum of 129 credits and satisfying the minimum credit requirements as mentioned in the table below.

4-year UG Degree (Honours): A four-year UG Honours degree in the major discipline will be awarded to those who complete a four-year degree, earning a minimum of 173 credits and have satisfied the credit requirements as mentioned in the table below.

4-year UG Degree (Honours with Research): Students who secure a minimum of 7.5 CGPA in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year. They should do a research project or dissertation under the guidance of a faculty member of the University. The research project/dissertation will be in the major discipline. The students who secure a minimum of 173 credits, including 12 credits from a research project, will be awarded a UG Degree (Honours with Research). Two courses of 4 credits each in the 8^{th} semester or other similar courses from an online platform i.e., NPTEL, can be done during vacation after the 7^{th} semester or in the 8^{th} semester and the student can go for a full-time project.

5.2 Exit Options

A student desiring an exit shall give a notice/ application of such intention in writing in the prescribed format at least 8 weeks before the scheduled end of the Academic year.
The Department running the programme shall on receipt of the notice recommend a Certificate/ Diploma/ Degree as the case may be from the University based on the requirements for such degrees.
In the case of arrear papers, the certificate shall be provided after passing the arrear paper.
As soon as the student completes the requirements of the certificate/diploma/degree, as the case may be, the Department shall communicate to such officer as may be notified by the Administration.

Candidates can exercise the following exit options and obtain the said certificate or diploma or degree if the minimum required credits are earned and other conditions are met.

Exit after 2^{nd} Semester: Certificate in electronics Circuit Designing/ Programming will be awarded to candidates who exit the course at the end of 2^{nd} semester and earned a minimum of

45 credits and have completed a Summer Internship of 4 credits for 4 – 6 weeks duration, during the summer vacation post 2nd semester.

Exit after 4th Semester: A diploma in Robotics/ 3D Designing will be awarded to candidates who exit the course at the end of the 4th semester and earned a minimum of 87 credits and have completed a Summer Internship of 4 credits for 4 – 6 weeks duration, during the summer vacation post 4th semester.

Exit after 6th Semester: UG Degree in Autonomous Vehicles and Systems (B.Sc. (AVS)) will be awarded to candidates who exit the course at the end of the 6th semester and earned a minimum of 129 credits and have completed a Summer Internship of 4 credits for 4 – 6 weeks duration, during the summer vacation post 6th semester.

Exit after	Credits and other requirements	Awards
2nd Semester	Min: 45 Credits, Internship 45 days	Certificate in Autonomous Vehicles and Systems
4th Semester	Min: 87 Credits, Internship 45 days	Diploma in Autonomous Vehicles and Systems
6th Semester	Min: 129 Credits, Internship 45 days	B.Sc. Autonomous Vehicles and Systems

5.3 Guidelines for Exit Points

After Completion of 1st Year: Certificate# for exiting students provided that they undergo a 4-credit Internship (8 weeks) during Summer Vacation in the given stream of skill training. (The training/ workshop can be provided by the college)

Options for four credits Internship are (Certificate in):

1. Website Designing
2. PCB and Electronic Circuit Design
3. Computer Programming (Python/ C/ C++/ JAVA)

Note: The Above hands-on sessions should be provided after the second-semester exam.

The student has to inform at the beginning of the 2nd semester about exiting with a 1-year completion certificate. If a student wants to do a 4-credit course, then it should be taken during summer Vacation or in 2nd semester from Swayam/ NPTEL (No theory course will be offered by the College during vacation between 2nd and 3rd semester. NPTEL/ Swayam courses can be attended).

#A certificate can be provided based on the Internship/ Hands-on sessions attended.

After Completion of 2nd Year: UG Diploma in Major Disciplinary course for Exiting Students after completing 4 Cr Summer Internship for 45 Days.

Hands-on workshop/ Hands-on internship

1. Computer-Aided Design & Finite Element Analysis
2. Computer Programming
3. 3D Designing and 3D Printing

OR

Additionally, a Four-credit course may be focused towards their skill development.

MJD9: Computer-Aided Design / Introduction to Robotics / Workshop Technology / Artificial Intelligence and Machine Learning for AVS

A diploma can be given in Autonomous Vehicles and Systems or Computer Programming or Robotics or Manufacturing Processes.

After Completion Of 3rd Year: A Bachelor of Science in Autonomous Vehicles and Systems will be given.

After Completion Of 4th Year: UG (Honours) Degree in ***Autonomous Vehicles and Systems.***

- UG (Hons) Degree by Research: For students who opt for a Research Project in the final semester.
- UG (Hons) Degree by Coursework: For those students who opt for three minor courses instead of a Research project.

6. PEDAGOGICAL APPROACHES

COURSE TYPES	APPROACH
a) Lecture Courses	Regular classroom lectures by qualified/experienced Expert Teachers • These Lectures may also include classroom discussion, demonstrations, case analysis • Use of Models, Audio-Visual contents, Documentaries, PPTs may supplement.
b) Tutorial Courses	Problem solving Exercise classes guided discussion, supplementary readings vocational training, etc.
c) Practical/ Lab work	Practical Lab activity with Theoretical support Mini projects, Activity-based engagement, Program executions, Data processing and presentation exercise.
d) Seminar Course	A course requiring student to design and participate in discussions, Group Discussions, Elocution and Debate, Oral Communication Paper presentations, Poster Presentation, Role play participation, Quiz competitions, Business plan preparation/presentation, etc.
e) Internship course	Courses requiring students to *Learn by Doing* in the workplace external to the educational Institutions. Internships involve working in Software Companies, Research and Higher Educational Institution Laboratories, Corporate Offices, etc.

	All Internships should be properly guided and inducted for focused learning.
f) Research Project	Students need to study and analyze the recent research publications from indexed/peer-reviewed journals in their area of specialization. The outcome of the study and analysis need to be presented as a thesis or research report with necessary experimental results.

7. ACADEMIC AUDIT OF COURSES

The Internal Quality Assurance Cell (IQAC) at every institution is expected to supervise the implementation of NEP Regulations in these programmes. Availability of the required number of Classrooms, Faculty rooms, Labs, Library facilities, Computer Centre and recruitment of Faculty members, allocation of funds for running the Science Labs/Computer Centre etc., is the responsibility of the University / College Administration.

8. ADMISSIONS & LATERAL ENTRY

8.1 Admissions Eligibility

The Candidates for admission to B.Sc. (AVS), shall be required to have passed 10 + 2 system of Examination or equivalent with Mathematics / Business Mathematics and physics as a main subject along with Information Technology / Computer Science / Electronics/ Electrical/ Computer Applications / Physics/ equivalent and relevant as one of the subjects of study.

Students shall be admitted to this programme based on admissions criteria fixed by the University / Government of Puducherry from time to time.

8.2 Lateral Entry

As per NEP, students have a choice of exit and entry into the programme multiple number of times. UGC specifies that about 10% of seats over and above the sanctioned strength shall be allocated to accommodate the Lateral Entry students.

Candidates who have passed a Diploma in Computer Science/ Information Technology/ Computer Technology/ Electronics/ Electrical/ Computer Application/ Mechanical/ Instrumentation/ Data Science/ Artificial Intelligence & Machine Learning/ Automobile/ Civil/ Aeronautical/ Production & Industrial Engineering/ Mechatronics/ Marine Engineering in I Class (10+3 years of study) are eligible to apply for the lateral entry to the 2nd year of the course subject to availability of seats.

Candidates seeking entry in the second, third and fourth year, should meet the necessary eligibility criteria with respect to the certificate/diploma / degree they possess, with necessary minimum credits banked in the Academic Bank of Credits (ABC). Such students who get admitted in later

years, other than the first year will be guided by the following clauses:

- that the University shall notify the admission process and number of vacancies open for lateral entry.
- that the Lateral entrants shall be admitted only after such a transparent screening process and such procedure that the University may prescribe from time to time. University may prescribe different methods of screening for different programmes depending on the circumstances prevailing in each case.
- Lateral entry shall be permissible only at the beginning of years 2, 3, and 4 of the Under Graduate / Honors programme; provided that the students seeking lateral entry shall have obtained the minimum pass marks/grades fixed by the University in their previous academic years.

9. EVALUATION (INTERNAL & END-SEMESTER ASSESSMENT) AND GRADES

All Credit courses are evaluated for 100 marks. The internal Assessment component is for 25 marks and the End Semester University exam is for 75 marks for theory courses. In case of practical courses, research project work etc., the Internal Assessment component is for 50 marks and the End Semester University exam is for 50 marks.

Internal Test Scheme: The principal of the College schedules the Mid-Semester Exam for all courses during 8/ 9th week of the start of classes. Mid-semester exams for 90 minutes' duration need to be conducted for all these theory courses. The evaluated marks need to be uploaded to Controller of Examinations of University. The answer books of Mid-Semester exams need to be preserved until the declaration of results by the University.

9.1 INTERNAL ASSESSMENTS (for Courses up to 6th Semester)

9.1.1 Internal Assessment Marks for Theory Subjects

The total Internal Assessment mark for a theory subject is 25 marks. The breakup is as follows:

Evaluation Component	Marks
A. Mid Semester Exam (one)	20
B. Percentage of Attendance	05
Total	**25**

9.1.2 Internal Assessment marks for Practical / Internships subjects

The faculty member in-charge of Lab practicals shall evaluate the practical subjects for 50 marks. The breakup is as follows:

Evaluation Component	Marks
A. Mid-Semester Practical Exam (one) / Viva-voce	20
B. Practical Record / Internship Report	25
C. Percentage of Attendance	05
Total	**50**

9.1.3 Internal Assessment Marks for Research Project Work

There shall be a faculty member assigned as a Project Guide for each candidate doing the Research Project. Progress of the candidate can be assessed once in a month in a project review meeting. Three project review meetings shall be conducted for Internal Assessment.

Project review committee may be constituted and the committee shall organize project review meetings and evaluate the progress and to award the Internal Assessment marks. Internal Assessment component for the Research Project is 50 Marks. The breakup is as follows:

Evaluation Component	Marks
A. Monthly Review (3 Reviews – 10 Marks each)	30
B. Project Report	10
C. Project Presentation and viva voce	10
Total	**50**

9.1.4 Internal Assessment Marks for Theory Subjects with Practical Components

Faculty member in-charge of Theory Subjects with Practical Component shall evaluate the candidates both for their performance in theory and practical. Internal Assessment marks for Theory Subjects with Practical Components is 25 marks. The breakup is as follows:

Evaluation Component	Marks
A. Mid Semester Exam (one)	15
B. Observation Note / Practical Record	05
C. Percentage of Attendance	05
Total	**25**

9.1.5 Marks for Attendance is as follows

Attendance %	Marks
Below 75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

9.2 END SEMESTER ASSESSMENT

Controller of Examinations (COE) of Pondicherry University schedules the End-Semester exams for all theory and practical subjects based on the university calendar. For Theory courses with Practical components, End-semester exams shall be conducted separately for Theory and Practical.

A detailed Exam Time Table shall be circulated at least 15 days before the start of exams, mostly during 15/16th week of the Semester. Question Papers shall be set externally based on BoS approved syllabus. All students who have a minimum of 70% attendance are eligible to attend the end-semester exams. Attendance percentage shall be calculated for each course to decide the eligibility of the candidate for writing the end-semester examination.

9.2.1 Breakup of End Semester Marks
(All End Semester Exams shall be conducted by the Pondicherry University)

The question paper shall be set as per the Bloom's Taxonomy. Various levels along with its description and sample questions are as follows:

Knowledge: Recall or remember previously learned information. Example: List the basic data types in Python.

Course Components	Max. Marks	End-Sem Exam Duration
A. Theory subjects: Sec A: 10 Questions of 2 Marks each (20 Marks) *(Knowledge: 3, Comprehension: 2, Application: 3, Analysis:2)* Sec B: 5 out of 7 Questions of 5 Marks each (25 Marks) *(Knowledge: 1, Comprehension: 2, Application: 1, Analysis:3)* Sec C: 2 Either/OR choice questions of 15 Marks each (30 Marks) *(Application: 1, Analysis:1)* **Questions from all units of Syllabus equally distributed.**	75 Marks	3 Hours
B. Skill Enhancement/ Practical/Internship/Project Work subjects: **Skill Enhancement / Practical Subjects:** Based on Practical Exams conducted by COE of University **Internship / Research Project Work:** Presentation of the work / Report / Viva-voce examinations	50 Marks	3 Hours --
C. Theory Subjects with Practical Components: **i. Theory Component:** Sec A: 5 Questions of 2 Marks each (10 Marks) *(Knowledge: 3, Comprehension: 2, Application: 3, Analysis:2)* Sec B: 5 out of 7 Questions of 4 Marks each (20 Marks) *(Comprehension: 2, Application: 3, Analysis:2)* Sec C: 2 Either or type questions of 10 Marks each (20 Marks) *(Analysis / Synthesis)* **Questions from all units of the Syllabus are equally distributed.** **ii. Practical Component:** Based on Practical Exams / Presentation / Viva-voce with an external examiner appointed by the University Controller of Examinations, and schedules exclusively prepared for such practical examinations by the University Examination Section. **The examination shall be conducted for 50 Marks and reduced to 25 Marks.** **Total Marks: 75 (Theory: 50 Marks + Practical: 25 Marks)**	50 Marks 25 Marks	3 Hours 3 Hours

Comprehension: Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating the main ideas.
Example: Explain how drones fly.

Application: Apply knowledge and concepts to solve problems in new situations. Use learned information in a different context.
Example: Make obstacles avoiding car.

Analysis: Break down information into parts and examine the relationships between the parts. Identify motives or causes.
Example: analyze the efficiency of two microcontrollers/ systems and compare their advantages and disadvantages.

Synthesis: Create a new whole by combining elements in novel ways. Use creativity to produce something original.
Example: Design an automated bot that can operate and work its own.

The distribution of questions at various levels are as indicated in table.

9.3 CONSOLIDATION OF MARKS AND PASSING MINIMUM

Controller of Examinations of the University consolidates the Internal Assessment marks uploaded by the Colleges and marks secured by students in End-Semester examinations. A student shall be declared to have passed the course only if she/he gets,

- A minimum of 40% marks in end semester exam and
- A minimum of 40% marks in aggregate when continuous

assessment and end-semester examination marks are put together.

9.3.1 Arrear Exam

A student who secures less than 40% marks in aggregate is declared as a ***Fail*** and that student is eligible to take up supplementary examination by registering to the failed course in the following Semester. All other candidates who failed due to shortage of attendance and those who are seeking to improve the grade shall repeat the course.

9.3.2 Letter Grades and Calculation of CGPA

Total marks secured by a student in each subject shall be converted into a letter grade. UGC

Framework has suggested a Country wide uniform letter grades for all UG courses. The following table shows the seven letter grades and corresponding meaning and the grade points for calculation of CGPA.

Equivalent Letter Grade	Meaning	Grade Points for Calculation of CGPA
O	Outstanding	10
A+	Excellent	9
A	Very Good	8
B+	Good	7
B	Above Average	6
C	Average	5
P	Pass	4
F	Fail	0
Ab	Absent	0

In order to work out the above letter grades, the marks secured by a student (Total of Internal Assessment and End Semester Assessment) would be categorized for relative grading.

The range of marks for each grade would be worked as follows:

- Highest marks in the given subject: X
- Cut of marks for grading purpose: 50 marks
- Passing minimum: 40
- Number of grades (except P - Pass) (O, A+, A, B+, B, C): G = 6
- Range of marks: K = (X - 50) / G

(i) If K ≥ 5, then the grades shall be awarded as given in the following table.

Range of Marks in %	Letter Grade Points for	Grade Points for
X to (X-K) + 1	O	10
(X-K) to (X-2K) + 1	A+	9
(X-2K) to (X-3K) + 1	A	8
(X-3K) to (X-4K) + 1	B+	7
(X-4K) to (X-5K) + 1	B	6
(X-5K) to 50	C	5
40 – 49	P	4
Below 40	F	0
Absent (Lack of Attendance)	Ab	0

(ii) If K< 5, then the grades shall be awarded as given in the following table.

Range of Marks in %	Letter Grade Points for	Grade Points for
80-100	O	10
71-79	A+	9
66-70	A	8
61-65	B+	7
56-60	B	6
50-55	C	5
40-49	P	4
Below 40	F	0
Absent (lack of attendance)	Ab	0

9.3.3 Calculation of Semester Grade Point Average and Cumulative Grade Point Average

Semester Grade Point Average (SGPA) is calculated by taking a weighted average of all grade points secured by a candidate from all subjects registered by him/her in the given Semester. The weights being the number of credits that each subject carries.

Cumulative Grade Point Average (CGPA) shall be calculated as the weighted average of credits that course carries and the value of Grade points averaged for all subjects.

9.3.4 Computation of SGPA and CGPA

The following procedure shall be followed to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student to the sum of the number of credits of all the courses undergone by a student, i.e. SGPA (S_i) = $\Sigma(C_i \times G_i) / \Sigma C_i$

where C_i is the number of credits of the i^{th} course and G_i is the grade point scored by the student in the i^{th} course.

(i) Example for Computation of SGPA where the candidate has not failed in any course

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 X 8 = 24
I	Course 2	4	B+	7	4 X 7 = 28
I	Course 3	3	B	6	3 X 6 = 18
I	Course 4	3	O	10	3 X 10 = 30
I	Course 5	3	C	5	3 X 5 = 15
I	Course 6	4	B	6	4 X 6 = 24
		20			139
				SGPA	**139/20=6.95**

(ii) Example for Computation of SGPA where the candidate has failed in one course

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 X 8 = 24
I	Course 2	4	B+	7	4 X 7 = 28
I	Course 3	3	B	6	3 X 6 = 18
I	Course 4	3	O	10	3 X 10 = 30
I	Course 5	3	C	5	3 X 5 = 15
I	Course 6	4	F	0	4 X 0 = 00
		20			115
				SGPA	**115/20=5.75**

(iii) Example for Computation of SGPA where the candidate has failed in two courses

Semester	Course	Credit	Letter Grade	Grade point	Credit Point (Credit x Grade)
I	Course 1	3	A	8	3 X 8 = 24
I	Course 2	4	B+	7	4 X 7 = 28
I	Course 3	3	F	0	3 X 0 = 00
I	Course 4	3	B	6	3 X 6 = 18
I	Course 5	3	C	5	3 X 5 = 15
I	Course 6	4	F	0	4 X 0 = 00
		20			85
				SGPA	**85/20=4.25**

The CGPA shall also be calculated similarly as shown in examples (i), (ii), and (iii) of SGPA for all subjects taken by the students in all the semesters. However, if any student fails more than once in the same subject, then while calculating CGPA, the credit and grade points related to the subject in which the student fails in multiple attempts will be restricted to one time only. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

In the case of audit courses offered, the students may be given (P) or (F) grade without any credits. This may be indicated in the mark sheet. Audit courses will not be considered towards the calculation of CGPA.

9.3.5 Declaration of Results

Controller of Examinations (COE) of the University shall declare the results of the given UG programme following the CGPA secured by students by the end of 6th Semester and 8th Semester.

9.3.6 Classification of Divisions

Range of CGPA	Result
9.0 – 10	First Class with distinction$^{\#}$
6.0 - 8.99	First Class
5.0 - 5.99	Second Class
4.0 - 4.99	Pass

Distinction will be awarded ONLY to those candidates who have cleared ALL subjects in the first attempt.

9.4 INTERNAL ASSESSMENT / END-SEMESTER ASSESSMENT / PASSING MINIMUM / GRADES (FOR 7TH & 8TH SEMESTERS)

Regulations are to be notified in the next revision after the confirmation from the University NEP committee.

10. MINIMUM CREDIT REQUIREMENTS

S. No	Component	3-year UG			4-year UG (Honors / Honors With research)		
		Credits	Courses	Cr/Course	Credits	Courses	Cr/Course
1	Major Disciplinary/ Interdisciplinary Courses	60	15	4	84	21	4
2	Minor Disciplinary/ Interdisciplinary Courses	24	6	4	36	9	4
3	Multi-Disciplinary Courses	9	3	3	9	3	3
4	Ability Enhancement Courses	13	8	1.5	13	8	1.5
5	Skill Enhancement Courses	7	3	2	6	3	2
6	Value-added courses	8	4	2	8	4	2
7	Summer Internship (MJD 12)	4 + 2	1	4	4	1	4
8	Community Engagement and Service	2	1	2	2	1	2
9	Research Project/Dissertation	--	--	--	12	Project or 3 Courses##	
Total		**128**			**173**		

##Note: *Honors students not undertaking research will do 3 courses for 12 credits in lieu of a research project/Dissertation.*

- MJD: Major Disciplinary (Compulsory – Hardcore Subjects)
- MID: Minor Disciplinary (Specialization Specific – Softcore Subjects)
- MLD: Multi-Disciplinary
- AEC: Ability Enhancement Courses
- SEC: Skill Enhancement Courses
- VAC: Value Added Courses
- Course Code: CS1MJ01(E) (BCS-B.Sc. Computer Science, 1-Semester, MJ-Component, 1- Course Number in the respective component, E-Elective)

11. CURRICULUM

FIRST SEMESTER

Sl. No.	Paper	Hours/Week			Duration of Exam	Max. Marks	Credits
		Lecture	Practical	Tutorial			
AEC1*	English I*	3	-		3	100	3
MID1	Problem Solving & Programming Fundamentals **Or** Data Base Management System **Or** Digital Logic and Computer Organization	3	2	-	3	100	4
MJD1	Engineering Mathematics	3	-	1	3	100	4
MJD2	Basic Sciences for Autonomous Vehicles and Systems	3	2	-	3	100	4
MD1*	Fundamentals of Biotechnology *	3	-	-	3	100	3
SEC 1	Programming Fundamentals Lab	-	4	-	3	100	2
VAC1*	Environmental Education*	2	-	-	3	100	2
VAC2*	Understanding India*	2	-	-	3	100	2
						Total	24

SECOND SEMESTER

Sl. No.	Paper	Hours/Week			Duration of Exam	Max. Marks	Credit
		Lecture	Practical	Tutorial			
AEC2*	Language*	3	-	-	3	100	3
MID2	Mathematics II **Or** Data Structures and Algorithms **Or** Python Programming	3	-	2	3	100	4
MJD3	Analog and Digital Electronics	3	2		3	100	4
MD2*	Energy in Everyday Life*	3	-		3	100	3
SEC2	Computer Programming Lab	-	4		3	100	2
VAC3	Health & Wellness* **Or** Yoga Education*	2			3	100	2
VAC4	Digital Technologies*	2		2	3	100	2
						Total	21

- Students exiting the programme after securing 45 credits will be awarded a UG Certificate in the relevant Discipline/Subject provided they secure 4 credits in work-based vocational courses offered during the summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during the first and second semester.
- UG Certificate can be offered in multiple streams pertaining to the major discipline.
- The student decides either to continue with the chosen major or request a change of major at the end of 2nd semester.
- The student declares the choice of minors and vocational stream related to the minor at the end of the second semester after exploring various courses.
  (The minor stream courses include vocational courses which will help the students to equip with job-oriented skills.)
- **After Completion of 1st Year**: Certificate[#] for exiting students provided that they undergo 4 credits Internship during Summer Vacation in the given stream of skill training.

Options for four credits Internship are:

- ❖ PCB Designing/ Electronic Circuit Design
- ❖ Python/ C/ C++ Programming
- ❖ Electronics Sensors

Note: The Above hands-on sessions should be provided after the second-semester exam.

The student has to inform the college at the beginning of the 2nd semester about exiting with a 1-year completion certificate. If student wants to do 4 credit courses, then it should be taken using NPTEL/ Swayam courses).

#A certificate can be provided based on the Internship/ Hands-on sessions attended.

THIRD SEMESTER

Sl. No.	Paper	Hours/Week			Duration of Exam	Max. Marks	Credits
		Lecture	Practical	Tutorial			
AEC3*	English II	3	-	-	3	100	3
MJD4	Introduction to Vehicle Systems	3	2	-	3	100	4
MJD5	Strength of Materials	3	2	-	3	100	4
MD3*	Introduction to Public Administration* **Or** Social Science* **Or** Commerce & Management*	3	-	-	3	100	3
MID3	Introduction to Microprocessor and Microcontroller **Or** Mathematics III **Or** Renewable Energy Sources and Applications	3	-	1	3	100	4
SEC3	Microprocessor and Microcontroller Lab	-	4	1	3	100	3
						Total	21

FOURTH SEMESTER

Sl. No.	Paper	Hours/Week			Duration of Exam	Max. Marks	Credits
		Lecture	Practical	Tutorial			
AEC4*	Languages courses* (Public Speaking and Open Seminar)	2	2		3	100	3
MJD6	Fluid Mechanics	3	-	2	3	100	4
MJD7	Fundamentals of Applied Thermodynamics	3	-	2	3	100	4
MJD8	Signals and Systems for AVS	3	-	2	3	100	4
MID4	Workshop Technology **Or** Principles of Cyber Security **Or** Data Warehousing	3	2		3	100	4
VAC5	Internship **Or** Training **Or** Industrial Visit **Or** Mini project in any academic institution with a report (Electronics or Energy sources or Software or Manufacturing)		4		3	100	2
						Total	21

- Students exiting the programme after securing 87 credits will be awarded a UG Diploma in the relevant Discipline /Subject, provided they secure an additional 4 credits in work-based vocational courses offered during summer term or internship / Apprenticeship.
- UG Diploma can be offered in multiple streams pertaining to the major discipline. Summer Internship could be initiated during holidays and continued to the Vth semester.

- **After Completion of 2nd Year**: UG Diploma in Major Disciplinary course for Exiting Students after completing 4 Cr Summer Internship for 45 Days.

OR

- Additionally, a Four-credit course may be focused towards their skill development.

  MJD: Computer-Aided Design / Introduction to Robotics / Workshop Technology / Artificial Intelligence and Machine Learning for AVS.

- Hands-on workshop and Diploma
  - UG diploma in Autonomous Vehicles and Systems with specialisation in *Computer-Aided Design & Finite Element Analysis*
  - UG diploma in Autonomous Vehicles and Systems with specialisation in Computer Programming
  - UG diploma in Autonomous Vehicles and Systems with specialization in Electronics and Robotics
  - UG diploma in Autonomous Vehicles and Systems with specialisation in 3D Designing, 3D Printing, and Rapid Prototyping

FIFTH SEMESTER

Sl. No.	Paper	Hours/Week			Duration of Exam	Max. Marks	Credits
		Lecture	Practical	Tutorial			
MJD9	Robotics and Systems Automation	3	2	-	3	100	4
MJD10	Computer-Aided Design	3	2	-	3	100	4
MJD11	Analog and Digital Communication Systems for Automation	3	2	-	3	100	4
MID5	Artificial Intelligence and Machine Learning for AVS **Or** Industrial Management **Or** Industry 4.0 and Industrial Internet of Things	3	-	1	3	100	4
MJD	Summer Internship (Computer-Aided Design/ Robotics/ AI & ML) **Or** **MJD 12:** Space Technology for AVS	3	-	1	3	100	4
						Total	20

SIXTH SEMESTER

Sl. No.	Paper	Hours/Week			Duration of Exam	Max. Marks	Credits
		Lecture	Practical	Tutorial			
MJD13	Control Systems for AVS	3	2	-	3	100	4
MJD14	Internet of Things for AVS	3	2	-	3	100	4
MJD15	Computational Fluid Dynamics (CFD)	3	2	-	3	100	4
MJD16	Kinematics and Dynamics of Machines	3	2	-	3	100	4
MID6	Manufacturing Processes **Or** Power Source and IC Engines **Or** Research Methodology & Intellectual Property Rights	3	2	-	3	100	4
VAC6	Entrepreneurship and E-Businesses	2		-	3	100	2
						Total	22

- Students who want to undertake a 3-year UG programme will be awarded a UG Degree in the relevant Discipline /Subject upon securing 129 credits.
- A minimum of 12 credits will be allotted to the minor stream relating to vocational education and training spreading through 2, 3, 4, and 5 semesters.
- Internship is included as the Major 12 course.
- **After Completion of 3rd Year**: A bachelor of Science (B.Sc.) in Autonomous Vehicles and Systems will be given.

SEVENTH SEMESTER

Sl. No.	Paper	Hours/Week			Duration of Exam	Max. Marks	Credits
		Lecture	Practical	Tutorial			
MJD17	Finite Element Methods	3	2		3	100	4
MJD18	Embedded System Design	3	2		3	100	4
MJD19	Flight Control System Design	4	-		3	100	4
MJD20	Electronics Sensors and Systems for AVS	3	2		3	100	4
MID7	Maintenance of AVS **Or** Blockchain Technology **Or** Cryptography and Network Security	3	2		3	100	4
MID8	Advanced Materials and Manufacturing for AVS **Or** Digital Image Processing for AVS **Or** Artificial Neural Networks for AVS	3	2		3	100	4
						Total	24

EIGHTH SEMESTER

Sl. No.	Paper	Hours/Week			Duration of Exam	Max. Marks	Credits
		Lecture	Practical	Tutorial			
MJD21	Satellite Communications for AVS	3	2	-	3	100	4
MJD22	Measurements and Experimental Testing	3	2	-	3	100	4
MJD	Research Project **Or**	12			3		
	Industrial Robotics and Automation **&** Drone Technologies **&** Non-Destructive Testing Methods	3	2			100 100 100	4 4 4
						Total	20

- Students will be awarded a UG Degree (Honours) with Research in the relevant Discipline /Subject provided they secure 173 credits.
- Honours students not undertaking research will do 3 courses for 12 credits instead of a research project / Dissertation.
- Students of UG honours with research will choose a research component in the 4th year and complete research methodology courses and advanced courses in major/minor.
- **After Completion of 4th Year**: BSc (Honours) Degree in ***Autonomous Vehicles and Systems.***
    - UG (Hons) Degree by Research: For students who opt for a Research Project in the final semester.
    - UG (Hons) Degree by Coursework: For those students who opt for three minor courses instead of a Research project.

12. List of Course and Course Code

CODE	Component	Course Code	**Major Disciplinary Courses** *(Compulsory – Hardcore Subjects)*	Cr	L	P	T
AVAS111	MJD 1	AV1MJ1	Engineering Mathematics	4	3	-	1
AVAS112	MJD 2	AV1MJ2	Basic Sciences for Autonomous Vehicles and Systems	4	3	2	-
AVAS121	MJD 3	AV2MJ3	Analog and Digital Electronics	4	3	2	-
AVAS231	MJD 4	AV3MJ4	Introduction to Vehicle Systems	4	3	2	-
AVAS232	MJD 5	AV3MJ5	Strength of Materials	4	3	2	-
AVAS241	MJD 6	AV4MJ6	Fluid Mechanics	4	3	-	2
AVAS242	MJD 7	AV4MJ7	Fundamentals of Applied Thermodynamics	4	3	-	2
AVAS243	MJD 8	AV4MJ8	Signals and Systems for AVS	4	3	-	2
AVAS351	MJD 9	AV5MJ9	Robotics and Systems Automation	4	3	2	-
AVAS352	MJD 10	AV5MJ10	Computer-Aided Design	4	3	2	-
AVAS353	MJD 11	AV5MJ11	Analog and Digital Communication Systems for Automation	4	3	2	-
AVAS354	MJD 12	AV5MJ12	Space Technology for AVS	4	3	-	1
AVAS361	MJD 13	AV6MJ13	Control Systems for AVS	4	3	2	-
AVAS362	MJD 14	AV6MJ14	Internet of Things for AVS	4	3	2	-
AVAS363	MJD 15	AV6MJ15	Computational Fluid Dynamics (CFD)	4	3	2	-
AVAS364	MJD 16	AV6MJ16	Kinematics And Dynamics of Machines	4	3	2	-
AVAS471	MJD 17	AV7MJ17	Finite Element Methods	4	3	2	-
AVAS472	MJD 18	AV7MJ18	Embedded System Design	4	3	2	-
AVAS473	MJD 19	AV7MJ19	Flight Control System Design	4	4		-
AVAS474	MJD 20	AV7MJ20	Electronics Sensors and Systems for AVS	4	3	2	-
AVAS481	MJD 21	AV8MJ21	Satellite and Radar Communications for AVS	4	3	2	-
AVAS482	MJD 22	AV8MJ22	Measurements and Experimental Testing	4	3	2	-
AVAS483	MJD 23	AV8MJ23	Industrial Robotics and Automation	4	3	-	1
AVAS484	MJD 24	AV8MJ24	Drone Technologies	4	3	-	1
AVAS485	MJD 25	AV8MJ25	Non-destructive Testing Methods	4	3	-	1
			Minor Disciplinary Courses *(Specialization Specific – Softcore Subjects)*				
AVAS113	MID1	AV1MI1	Problem Solving & Programming Fundamentals	4	3	2	-
AVAS113	MID1	AV1MI2	Data Base Management System	4	3	2	-
AVAS113	MID1	AV1MI3	Digital Logic and Computer Organization	4	3	2	-
AVAS122	MID 2	AV2MI4	Mathematics II	4	3	-	1
AVAS122	MID 2	AV2MI5	Data Structures and Algorithms	4	3	2	-
AVAS122	MID 2	AV2MI6	Python Programming	4	3	2	-
AVAS233	MID 3	AV3MI7	Introduction to Microprocessor and Microcontroller	4	3	2	-
AVAS233	MID 3	AV3MI8	Mathematics III	4	3	2	-

AVAS233	MID 3	AV3MI9	Renewable Energy Sources and Applications	4	3	-	1
AVAS244	MID 4	AV4MI10	Workshop Technology	4	3	-	-
AVAS244	MID 4	AV4MI11	Principles of Cyber Security	4	3	-	1
AVAS244	MID 4	AV4MI12	Data Warehousing	4	3	-	1
AVAS355	MID 5	AV5MI13	Artificial Intelligence and Machine Learning for AVS	4	3	-	1
AVAS355	MID 5	AV5MI14	Industrial Management	4	3	-	1
AVAS355	MID 5	AV5MI15	Industry 4.0 and Industrial Internet of Things	4	3	-	1
AVAS365	MID 6	AV6MI16	Manufacturing Processes	4	3	-	1
AVAS365	MID 6	AV6MI17	Power Source and IC Engines	4	3	-	1
AVAS365	MID 6	AV6MI18	Research Methodology & Intellectual Property Rights	4	3	-	1
AVAS475	MID 7	AV7MI19	Maintenance of AVS	4	3	-	1
AVAS475	MID 7	AV7MI20	Blockchain Technology	4	3	-	1
AVAS475	MID 7	AV7MI21	Cryptography and Network Security	4	3	-	1
AVAS476	MID 8	AV7MI22	Advanced Materials and Manufacturing for AVS	4	3	-	1
AVAS476	MID 8	AV7MI23	Digital Image Processing for AVS	4	3	-	1
AVAS476	MID 8	AV7MI24	Artificial Neural Networks for AVS	4	3	-	1
S. No.	**Component**	**Course Code**	**Ability Enhancement Courses**	**C**	**L**	**P**	**T**
	AEC1	AV1AE1	English I	3	3	-	-
	AEC2	AV2AE2	Language I	3	3	-	-
	AEC3	AV3AE3	English II	3	3	-	-
	AEC2	AV4AE4	Language II	3	3	-	-
			Multi-Disciplinary Courses				
	MD 1	AV1MD1	Fundamentals of Biotechnology	3	3	-	-
	MD 2	AV2MD2	Energy in Everyday Life	3	3	-	-
	MD 3	AV3MD3	Introduction to Public Administration	3	3	-	-
			Value Added Courses				
	VAC 1	AV1VA1	Environmental Education	2	2	-	-
	VAC 2	AV1VA2	Understanding India	2	2	-	-
	VAC 3	AV2VA3	Health & Wellness, Yoga Education	2	2	-	-
	VAC 4	AV2VA4	Digital Technology	2	1	2	-
	VAC 5	AV4VA5	Internship	2	-	-	-
	VAC 6	AV4AV6	Entrepreneurship and E-Businesses	2	2	-	-
			Skill Enhancement Courses				
	SEC 1	AV1SE1	Programming Fundamentals Lab	2	-	4	-
	SEC 2	AV2SE2	Computer Programming Lab	2	-	4	-
	SEC 3	AV3SE2	Microprocessor and Micro controller Lab	2	-	4	-

SYLLABUS

FIRST SEMESTER

AVAS113 (AV1MI1): PROBLEM-SOLVING & PROGRAMMING FUNDAMENTALS

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic knowledge of Mathematics and Computers.

Course Objective

- Introduce students to the fundamentals of the programming languages
- Develop problem-solving skills using programming constructs
- Enable students to design, write, debug, and run programs
- Encourage logical thinking and algorithmic problem-solving approaches
- Apply problem-solving techniques to real-world scenarios using computer languages

Course Outcome

- Ability to comprehend and write basic to intermediate programs
- Understanding of algorithms and data structures
- Proficiency in identifying, analysing, and solving problems using programming
- Capable of developing efficient and logical solutions to programming challenges
- Skills to apply learned concepts in practical programming situations

Unit I: Introduction to Computer Problem-Solving **9**

The Problem-solving Aspect-Top-down Design - Implementation of Algorithms - Program Verification - The Efficiency of Algorithms - The Analysis of Algorithms.

Unit II: Basic Programming Constructs **9**

Basic Data types (Numerical, String) – Variables – Expressions – I/O statements – Compile and Run - Debugging.

Unit III: Decision Making **9**

Branching & Looping Decision making – Relational Operators - Conditional statement, Looping statement - Nested loops - Infinite loops - Switch statements.

Unit IV: Array Techniques **9**

Array Manipulation - Different operations - one-dimensional array - two-dimensional array - multi-dimensional array - Character Arrays and Strings.

Unit V: Modular Solutions **9**

Introduction to functions Importance of design of functions – Arguments – Parameters – return values – local and global scope – Recursion

TEXTBOOK

1. P R. G. Dromey, *How to solve it by Computer*, Pearson Education, 2007.
2. E. Balaguruswamy, *Programming in ANSI C*, 8th edition, TMH Publications, 2019.
3. Yashwant Kanetkar, *Let Us C*, 18th Edition, PHP, 2022.
4. Allen B. Downey, *Think Python: How to Think like a Computer Scientist*, 2nd Edition, O'Reilly Publishers, 2016.

REFERENCE BOOKS

1. G. Perry and D. Miller, *C Programming Absolute Beginner's Guide*. Indianapolis, IN, USA: Que Publishing, 2013.
2. M. Vine, *C Programming for the Absolute Beginner*. 3rd edition, Boston, MA, USA: Course Technology PTR, 2014.
3. D. Griffiths and D. Griffiths, *Head First C: A Brain-Friendly Guide*. Sebastopol, CA, USA: O'Reilly Media, 2012.

Online Study Material

Websites:

- GeeksforGeeks: Programming Language
- Tutorialspoint: Programming
- Codecademy: Learn C
- Stack Overflow: C Tag

Video Resources:

- YouTube channels such as "TheNewBoston," "mycodeschool," and "ProgrammingKnowledge"
- Online platforms like NPTEL, Coursera, Udemy, and edX offer C programming courses

Practical Platforms:

- HackerRank, LeetCode, CodeSignal, and CodeChef for practicing C programming problems
- Exercism.io for C track exercises

PRACTICAL COMPONENT

List of Exercises **30**

1. Program to array counting, array order reversal & find the maximum number in a set.
2. Program for removal of duplicates from an ordered array & to partition an array.
3. Program to find the kth smallest element.
4. Program to exchange the values of two variables without using a third variable.
5. Program that takes a list of numbers as input and counts the total number of elements

in the list.

6. Program to calculate the sum of a set of numbers entered by the user.
7. Program to compute the factorial of a given integer.
8. Program to compute the sine of an angle (in degrees) using a series expansion.
9. Program to generate the Fibonacci sequence up to a specified limit.
10. Program that takes an integer as input and reverses its digits.
11. Program that converts a number from one base to another (e.g., binary to decimal, decimal to binary).

TEXTBOOK

1. P. Padmanabham, *C Programming and Data Structures*, 3rd ed. Hyderabad, India: BS Publications, 2008.
2. V. Rajaraman, *Computer Programming in C*. 2nd edition, New Delhi, India: PHI Learning, 2004.
3. E. Balagurusamy, *C Programming*, 3rd ed. New Delhi, India: Tata McGraw-Hill Education, 2006.
4. M. V. S. S. N. Venkateswarlu and E. V. Prasad, *C Programming*. 1st edition, New Delhi, India: S. Chand & Company Ltd., 2010.
5. K. R. Venugopal and S. R. Prasad, *Mastering C*. 2nd edition, New Delhi, India: Tata McGraw-Hill Education, 2017.

AVAS113 (AV1MI2): DATABASE MANAGEMENT SYSTEM

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic knowledge of computer systems and their functioning.
- Understanding of fundamental data structures.
- Familiarity with basic concepts of information technology.
- Knowledge of data structures and file handling.

Course Objective

- Introduce the fundamental concepts of database management systems (DBMS).
- Teach the principles of database design, organization, and management.
- Explore different database models and their application in real-world scenarios.
- Enable students to use query languages to retrieve and manipulate data.
- Familiarize students with the importance of data security and integrity.

Course Outcome

- Understanding of database architecture and the functioning of DBMS.
- Proficiency in designing and implementing databases.
- Capability to write and execute basic to intermediate-level SQL queries.
- Ability to comprehend and apply normalization techniques.
- Knowledge of data integrity, security, and backup strategies in database management.

Unit I: Overview of Database Management System **9**

Introduction, file-based system, drawbacks of file Based System, Data and information, Database, Database management System, Objectives of DBMS, Evaluation of Database management system, classification of Database Management System, DBMS Approach, advantages of DBMS, Anis/spark Data Model, data models, Components and Interfaces of Database Management System - Database Architecture, situations where DBMS is not Necessary - DBMS Vendors and their Products.

Unit II: Entity-Relationship Model **9**

Introduction, the building blocks of an entity relationship diagram, classification of entity sets, attribute classification, relationship degree, relationship classification, reducing ER diagram to tables, enhanced entity-relationship model (EER model), generalization and specialization, ISA relationship and attribute inheritance, multiple inheritance, constraints on specialization and generalization, aggregation and composition - advantages of ER modeling.

Unit III: Relational Model **9**

Introduction - ACID property - CODD Rules, relational data model, concept of key, relational integrity – primary key – foreign key - normalization – 1st normal form, 2nd normal form & 3rd normal form.

Unit IV: Structured Query Language **9**

Introduction, History of SQL Standard, Commands in SQL, Data Types in SQL, Data Definition Language, Data Manipulation Language, Data Control Language Table Modification Commands – primary & foreign keys.

Unit V: PL/SQL **9**

Introduction, Shortcoming in SQL, Structure of PL/SQL, PL/SQL Language Elements, Data Types, Operators Precedence, Control Structure, steps to Create a PL/SQL, steps to create a Cursors, Procedure, Function, Packages, Exceptions Handling, Database Triggers, Types of Triggers.

TEXTBOOK

1. A. Silberschatz, H. Korth, and S. Sudarshan, *Database System Concepts*, 6th ed. New York, NY, USA: McGraw-Hill Education, 2010.
2. R. Elmasri and S. B. Navathe, *Fundamentals of Database Systems*, 7th ed. Boston, MA, USA: Pearson Education, 2016.
3. W. Shields, *SQL QuickStart Guide: The Simplified Beginner's Guide to Managing, Analyzing, and Manipulating Data With SQL*. ClydeBank Media LLC, 2019.
4. M. J. Hernandez, *Database Design for Mere Mortals: A Hands-On Guide to Relational Database Design*, 3rd edition, Indianapolis, IN, USA: Addison-Wesley Professional, 2013.

REFERENCE BOOKS

1. B. Forta, *SQL in 10 Minutes, Sams Teach Yourself*, 5th edition, Indianapolis, IN, USA: Sams Publishing, 2019.
2. A. Beaulieu, *Learning SQL: Master SQL Fundamentals*, 3rd edition, Sebastopol, CA, USA: O'Reilly Media, 2020.
3. R. Kimball and M. Ross, *The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling*, 3rd edition, Indianapolis, IN, USA: Wiley, 2013.
4. P. J. Sadalage and M. Fowler, *NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence*. 1st edition, Boston, MA, USA: Addison-Wesley, 2013.
5. W. Kent, *Data and Reality*, 3rd ed. Sebastopol, CA, USA: O'Reilly Media, 2012.

Online Study Material

Websites:

- W3Schools: SQL Tutorial
- Tutorialspoint: DBMS Tutorial
- Oracle's LiveSQL for practicing SQL queries
- Coursera: Database Management Courses

Video Resources:

- YouTube channels like "Academind" and "The Net Ninja" for database tutorials
- Platforms like Udemy and LinkedIn Learning offer database management courses.

Practical Platforms:

- HackerRank and LeetCode for practicing SQL problems
- SQLZoo for interactive SQL practice

List of Experiments (Any 10 Experiments) **30**

1. Determination of dissolved oxygen in water.
2. Determination of total hardness of water by EDTA method.
3. Determination of carbonate and bicarbonate in water.
4. Estimation of chloride content in water.
5. Estimation of magnesium by EDTA.
6. Estimation of acetic acid in vinegar.
7. Estimation of ferrous by permanganometry.
8. Magnetism: i-h curve.
9. Field along the axis of coil carrying current.
10. Vibration magnetometer – calculation of magnetic moment & pole strength.
11. Laser experiment: wavelength determination using transmission grating reflection. grating (vernier callipers) & particle size determination.
12. Determination of optical absorption coefficient of materials using laser.
13. Determination of the numerical aperture of an optical fiber.
14. Electrical conductivity of semiconductor – two probe / four probe method.
15. Hall effect in semiconductor.

AVAS113 (AV1MI3): DIGITAL LOGIC & COMPUTER ORGANIZATION

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic understanding of mathematics, particularly in binary arithmetic.
- Familiarity with introductory programming concepts.
- Fundamental knowledge of logic gates and Boolean algebra.
- Some exposure to computer architecture and assembly language.

Course Objective

- Introduce digital logic design principles and fundamentals.
- Teach computer organization and architecture concepts.
- Explore logic gates, combinational and sequential circuits.
- Enable students to understand memory, CPU, and I/O organization.
- Focus on the relationship between hardware and software.

Course Outcome

- Understanding of digital logic design and implementation.
- Proficiency in analysing and designing combinational and sequential circuits.
- Capability to comprehend computer organization and architecture.
- Ability to evaluate and optimize computer system performance.
- Skills to apply concepts in the design of basic computer systems.

Unit I: Number Systems & Conversions **9**

Arithmetic of number systems – binary codes – BCD – The excess – 3code Gray code – ASCII – EBCDIC - Introduction to Logic Circuits – logic functions & gates – Inversion – truth tables – logic gates – truth table of basics gates – timing diagrams of NOT, AND & OR gates – Boolean algebra – NAND& NOR logic gates - truth table of a logic circuit – de-morgan's theorem.

Unit II: Logic Families **9**

factors affecting performance of a logic family – register transistor logic – diode transistor logic – DCTL – ECL – TTL logic family – Karnaugh maps – two, three & four-variables K-map – loops in K-map – mapping of K-maps – don't care condition

Unit III: Sequential Logic Circuits **9**

Sequential circuits – SR flip flop – D flip flop – JK flipflop – T flip flop – flip flop triggering – Shift registers – data movements in digital systems – classification of counters – Combinatorial logic circuits – designing procedure– code converters – multiplexers – multiplexer tree – demultiplexers/ decoders – half & full adder – half & full subtractor – encoders – BCD adder.

Unit IV: Basic Structure of Computers **9**

Computer Types, Functional Modules, Basic operational Concepts, Bus Structures, Software, Performance, Multiprocessors and Multi-computers, Historical perspective - Input/Output Organization - Accessing I/O devices, Interrupts, Processor examples, Direct memory access, Buses, Interface circuits, Standard I/O interfaces.

Unit V: Memory System **9**

Basic concepts, Semi-conductor RAM memories, Read- only memories, Speed, Size and Cost, Cache memories, Performance considerations, Virtual Memories, memory management requirements, Secondary Storage.

TEXTBOOK

1. M. Mano, *Digital Logic and Computer Design*, 4th ed. Pearson Education, 2014.
2. S. S. Bhatti and R. Malhotra, *A Textbook of Digital Electronics*. 1st edition, New Delhi, India: I.K. International Publishing, 2013.
3. C. Hamacher, Z. Vranesic, and S. Zaky, *Computer Organization*, 5th ed. New York, NY, USA: McGraw-Hill, 2002.
4. D. Harris and S. Harris, *Digital Design and Computer Architecture*. 2nd edition, San Francisco, CA, USA: Morgan Kaufmann Publishers, 2012.
5. D. A. Patterson and J. L. Hennessy, *Computer Organization and Design: The Hardware/Software Interface*. 5th edition, San Francisco, CA, USA: Morgan Kaufmann Publishers, 2014.

REFERENCE BOOKS

1. R. P. Jain, Modern Digital Electronics, 4th ed. New York, NY, USA: McGraw-Hill Education, 2003.
2. W. Stallings, Computer Organization and Architecture: Designing for Performance, 10th ed. Boston, MA, USA: Pearson Education, 2016.
3. A. S. Tanenbaum, Structured Computer Organization, 6th ed. Upper Saddle River, NJ, USA: Prentice Hall, 2013.
4. C. H. Roth Jr. and L. L. Kinney, Logic Design, 7th ed. Clifton Park, NY, USA: Cengage Learning, 2014.

Online Study Material

Websites:

- Coursera: Computer Architecture and Digital Logic Courses
- MIT OpenCourseWare: Digital Systems and Computer Organization

- NPTEL: Digital Circuits and Systems Courses

Video Resources:

- YouTube channels like "Neso Academy" and "The Organic Chemistry Tutor"
- Online platforms like Coursera, Udemy, and edX offer courses on digital logic and computer organization.

Simulation Tools:

- Digital circuit simulators like Logisim, Xilinx ISE, or ModelSim.
- Assembly language emulators for practical CPU architecture understanding.

Additional Resources

- Participation in lab sessions for hands-on experience with digital circuits.
- Access to research papers and articles in digital logic and computer organization.
- Collaboration with peers and professors for deeper discussions and practical projects.

DIGITAL ELECTRONICS LAB

List of Exercises **30**

1. Study of Logic Gates
2. Design of Adder and Subtractor
3. Design and Implementation of Code Convertors
4. Design of 4-Bit Adder and Subtractor
5. Design and Implementation of Magnitude Comparator
6. 16 Bit Odd/Even Parity Checker and Generator
7. Design and Implementation of Multiplexer and Demultiplexer
8. Design and Implementation of Encoder and Decoder
9. Design and Implementation of 3 Bit Synchronous Up/Down Counter
10. Design and Implementation of Shift Register
11. Simulation of Logic Gates
12. Simulation of Adder and Subtractor
13. Design of 4-Bit Adder and Subtractor

AVAS111 (AV1MJ1): ENGINEERING MATHEMATICS

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic understanding of algebra and trigonometry
- Proficiency in fundamental arithmetic operations
- Familiarity with pre-calculus concepts

Course Objective

- Introduce fundamental mathematical concepts and techniques.
- Develop problem-solving skills within various branches of mathematics.
- Lay a strong foundation for calculus and higher-level mathematics.
- Enable students to comprehend and apply mathematical principles in various real-world scenarios.
- Enhance logical thinking, reasoning, and analytical skills.

Course Outcome

- Proficiency in solving algebraic equations and inequalities.
- Understanding of functions, limits, and continuity.
- Competence in differential calculus, including derivatives and applications.
- Mastery of integral calculus, including definite and indefinite integrals.
- Ability to apply learned concepts to real-life problems.

Unit I: Linear Algebra **9**

Algebra of matrices, inverse, rank, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-Hermitian and unitary matrices. Eigenvalues and eigenvectors, diagonalisation of matrices.

Calculus: Functions of single variable, limit, continuity and differentiability, Mean value theorems, Indeterminate forms and L'Hospital rule, Maxima and minima. Evaluation of definite and improper integrals, Functions of two variables, limit, continuity, partial derivatives, total derivatives, maxima and minima, double and triple integrals and their applications.

Unit II: Complex Variables **9**

Analytic functions, Cauchy-Riemann equations, Application in solving potential problems, Line integral, Cauchy's integral theorem and integral formula (without proof).

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) applications.

Unit III: Ordinary Differential Equations **9**

First order equation (linear and nonlinear), Second order linear differential equations with variable coefficients, Variation of parameters method, higher-order linear differential equations with constant coefficients, Cauchy- Euler's equations, power series solutions.
Partial Differential Equations: Separation of variables method, Laplace equation, solutions of one-dimensional heat and wave equations.

Unit IV: Probability and Statistics **9**

Definitions of probability and simple theorems, conditional probability, Bayes Theorem, random variables, discrete and continuous distributions, Binomial, Poisson, and normal distributions, correlation and linear regression.

Unit V: Numerical Methods **9**

Solution of a system of linear equations by L-U decomposition, Gauss-Jordan and Gauss-Seidel Methods, Newton's interpolation formulae, Solution of a polynomial and a transcendental equation by Newton-Raphson method, numerical integration by trapezoidal rule, Simpson's rule and Gaussian quadrature, numerical solutions of first-order differential equation by Euler's method and 4th order Runge-Kutta method.

TEXTBOOK

1. Kreyszig, E., Advanced Engineering Mathematics, 10th edition. John Wiley & Sons, 2010.
2. Thomas Jr, George B., Weir, Maurice D. and Hass, Joel R., Thomas' Calculus, 12th edition. Pearson 2014.
3. O'Neil, Peter V., Advanced Engineering Mathematics, 7th edition. Cengage learning, 2011.
4. Strang, G., Linear Algebra and its Applications, Fourth Edition, 2009.
5. Thomas, G.B. and Finney, R.L., Calculus and Analytic Geometry, 9th Edition, Pearson, Reprint, 2002.

REFERENCE BOOKS

1. N.P. Bali and Manish Goyal, *A Text Book of Engineering Mathematics*, 6th edition, Lakshmi Publications, New Delhi, 2013.
2. Gilbert Strang, *Introduction to Linear Algebra*, 6th edition, Wellesley-Cambridge Press, U.S., 2023.
3. Sandor Lehoczky and Richard Rusczyk, *The Art of Problem Solving*, Vol. 1: The Basics, 7th edition, Aops Inc., Alpine, California, 2019.
4. John B. Fraleigh, *A First Course in Abstract Algebra*, 8th edition, Pearson Education, 2013.
5. Daniel J. Velleman, *How to Prove It: A Structured Approach*, 3rd edition, Cambridge University Press, 2019.

Online Study Material
Websites:

- Khan Academy: Mathematics - Calculus, Algebra
- Brilliant.org: Math and Science Courses
- Paul's Online Math Notes: Calculus
- Coursera: Mathematics Courses

Video Resources:

- YouTube channels like "3Blue1Brown," "Professor Leonard," and "Khan Academy"
- Online platforms such as Coursera, Udemy, and edX offer mathematics courses.

Practical Platforms:

- Wolfram Alpha for computational problem-solving
- Symbolab for step-by-step solutions
- Desmos for visualizing mathematical concepts

AVAS112 (AV1MJ2): BASIC SCIENCE FOR AUTONOMOUS VEHICLES AND SYSTEMS

L	T	P	C	45L
3	0	2	4	

Prerequisites: NIL

Course Objective

- To acquaint the students with the basic concepts of chemistry in the industry and Engineering field.
- To understand the new developments and breakthroughs efficiently in engineering and technology.
- To provide an overview of the fundamentals of dielectrics and their applications.
- To identify the importance of nanoscale, quantum confinement and various fabrication techniques.

Course Outcome

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

- Analyse microscopic chemistry in terms of atomic and molecular orbital and intermolecular forces.
- Rationalize bulk properties and processes using thermodynamic considerations.
- Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques.
- Rationalize periodic properties such as ionization potential, electronegativity, oxidation states and drug molecules.
- Learn the major chemical reactions that are used in the synthesis of molecules.

Unit I: **Atomic and Molecular Structure** **9**

Schrodinger equation. Particle in a box solutions and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicentre orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity.

Unit II: **Spectroscopic Techniques and Applications** **9**

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques. Diffraction and scattering.

Unit III: **Periodic Properties** **9**

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries.

Unit IV: Relativistic Mechanics **9**

Inertial and Non- Inertial Frames of references, Galilean transformation equations, Michelson Morley Experiment, Lorentz Transformation equations, Length contraction, Time dilation and its experimental evidence, Relativistic velocity addition formula, Relativistic variation of mass with velocity, Evidence of variation of mass with velocity.

Unit V: **Materials of Technological Importance** **9**

Dielectric Materials: Electric field in presence of dielectric medium, concept of electric polarization, different types of polarizations, behaviour of dielectric in a.c. field, concept of dielectric loss and loss energy and their importance, Superconducting Materials.

Semiconducting Materials: Concept of energy bands in solids, carrier concentration and conductivity in intrinsic semiconductors and their temperature dependence.

Nano Materials: Basic principles of nanoscience and technology, applications of nanotechnology.

TEXTBOOK

1. B. H. Mahan and R. J. Meyers, *University Chemistry*, 4th ed. New Delhi, India: Pearson Publications, 2009.
2. R. K. Shukla, *Engineering Physics*, Vol. II. New Delhi, India, Pearson Education, 2014.
3. R. K. Shukla, *Electrical Engineering Materials*, 1st ed. New York, NY, USA, McGraw Hill, 2012.
4. R. K. Shukla, *Principles of Engineering Physics*, 1st ed. New Delhi, India: Ira Books, 2011.
5. S. K. Gupta, *Engineering Physics – I & II*. Meerut, India: Krishna Prakashan Media (P) Ltd., 2014.

REFERENCE BOOKS

1. B. L. Tembe, Kamaluddin, and M. S. Krishnan, *Engineering Chemistry*, New Delhi, India: Tata McGraw-Hill Education, 2018.
2. P. Atkins, *Physical Chemistry*, 8th ed. Oxford, UK: Oxford University Press, 2018.
3. K. P. C. Vollhardt and N. E. Schore, *Organic Chemistry: Structure and Function*, 5th ed. New York, NY, USA, W. H. Freeman and Company, 2005.
4. A. Beiser, *Concepts of Modern Physics*, 6th ed. New York, NY, USA: McGraw-Hill Education, 2003.
5. D. J. Griffiths, *Introduction to Electrodynamics*, 4th ed. Cambridge, UK, Cambridge University Press, 2017.

BASIC SCIENCE FOR AUTONOMOUS VEHICLES AND SYSTEMS LAB

List of Experiments (Any 10 Experiments) **30**

1. Determination of dissolved oxygen in water.
2. Determination of total hardness of water by EDTA method.
3. Determination of carbonate and bicarbonate in water.
4. Estimation of chloride content in water.
5. Estimation of magnesium by EDTA.
6. Estimation of acetic acid in vinegar.
7. Estimation of ferrous by permanganometry.
8. Magnetism: i-h curve
9. Field along the axis of coil carrying current
10. Vibration magnetometer – calculation of magnetic moment & pole strength
11. Laser experiment: wavelength determination using transmission grating,
12. reflection grating (vernier calipers) & particle size determination
13. Determination of optical absorption coefficient of materials using laser
14. Determination of numerical aperture of an optical fiber
15. Electrical conductivity of semiconductor – two probe / four probe method
16. Hall effect in semiconductor

AV1MD1: FUNDAMENTALS OF BIOTECHNOLOGY

L	T	P	C	45L
3	0	0	3	

Prerequisites: NIL

Course Objective

This course introduces the basics and fundamental concepts of biotechnology that cover the diversity of life, different kingdoms of living life, as well as applications of biotechnology in several fields.

Course Outcome

The students will be able to learn the basics of biology, classification of living organisms, nomenclature, and anatomy of different living systems. Also, they will learn cell biology and the application of biotechnology.

Unit I: Biodiversity and Classification **9**

Classification of the living organisms -five kingdom classification concepts. Salient features of animals-non-chordates up to phylum level and chordates up to class level; salient features of plants -Angiosperms up to class.

Unit II: Structural Arrangements of Animal and Plant Systems **9**

Anatomy and functions of animal organs- digestive, circulatory, respiratory, nervous, and reproductive. Anatomy and functions of dicots and monocots plants.

Unit III: Cell-Fundamental Unit of Life **9**

Differentiate between plant and animal cells; cell envelope; cell membrane, and cell wall. Cellular organelles - structure and function; endoplasmic reticulum, Golgiapparatus, lysosomes, vacuoles, mitochondria, ribosomes, plastids, microbodies; cytoskeleton, cilia, flagella, centrioles; nucleus.

Unit IV: Human Diseases and Public Health Issues **9**

Pathogens and parasites causing human diseases (dengue, chikungunya, dengue, filariasis, ascariasis, typhoid, pneumonia, common cold, amoebiasis, ring worm) and their control; cancer, diabetes, HIV and AIDS; Adolescence - drug and alcohol abuse.

Unit V: Biotechnological Applications **9**

General perspectives of Biotechnology: Genetic engineering applications of biotechnology. Application of Biotechnology in health and agriculture: Production of Human insulin and vaccines.

TEXTBOOKS

1. G. Cooper, *The Cell: A Molecular Approach*, 8th edition, Oxford University Press, 2019.
2. F. A. Khan, *Biotechnology Fundamentals*, 2nd edition, CRC Press, 2017.
3. D. E. Sadava, D. M. Hillis, H. C. Heller, and M. Berenbaum, *Life: The Science of Biology*, 10th edition, 2012.
4. P. H. Raven, R. F. Evert, and S. E. Eichhorn, *Biology of Plants*, 7th edition, New York: W.H. Freeman and Company, 2005.
5. R. Y. Stanier, E. A. Adelberg, and J. L. Ingraham, *General Microbiology*, 5th edition, MacMillan Press, 2007.

AV1VA1: ENVIRONMENTAL STUDIES

L	T	P	C	45L
2	0	0	2	

Prerequisites

- Basic knowledge of the Environment.

Course Objective

- Raise awareness among students about environmental issues, challenges, and concerns facing local, regional, and global ecosystems.
- Develop a comprehensive understanding of ecological principles, environmental science, and the interrelationships between humans and the environment.
- Promote the concept of sustainability and sustainable development.
- Encourage an interdisciplinary approach to studying the environment, integrating knowledge and perspectives from many fields.

Course Outcome

- Demonstrate Knowledge, analyse Environmental Issues
- Apply Scientific Methods, Communicate Effectively.
- Collaborate and evaluate Sustainability.
- Ethical Decision-Making, Engage in Environmental Advocacy.
- Contribute to Solutions, Reflect and Adapt.

Unit I: Multidisciplinary Nature of Environmental Studies **3**

1. Definition, scope and importance; Need for public awareness.
2. Environmental ethics: Issues and possible solutions
3. Environment Protection Act.

Unit II: Natural Resources, Renewable and Non-renewable Resources **5**

1. Forest resources: Use and over-exploitation, deforestation, Timber extraction.
2. Water resources: Use and over-utilization of surface and ground water, floods, drought, dams-benefits and problems.
3. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture,
4. Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources.
5. Land resources: Land as a resource, land degradation, soil erosion and desertification.

Unit III: Ecosystems **7**

1. Concept of an ecosystem.
2. Structure and function of an ecosystem.
3. Energy flow in the ecosystem.
4. Food chains, food webs and ecological pyramids.
5. Characteristic features, structure and function of: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems.

Unit IV: Biodiversity and Its Conservation **7**

1. Introduction – Definition: genetic, species and ecosystem diversity.
2. Biogeographical classification of India, India as a mega-diversity nation
3. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic values.
4. Hot spots of biodiversity.
5. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.
6. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit V: Environmental Pollution 8

1. Definition, cause, effects and control measures of: Air pollution, Water pollution, Soil pollution, Noise pollution, Thermal pollution, and Nuclear hazards.
2. Solid waste management: Causes, effects and control measures of urban and industrial wastes.
3. Disaster management: floods, earthquake, cyclone and landslides.

TEXTBOOK

1. E. P. Odum and G. W. Barrett, *Fundamentals of Ecology*, 5th edition, Boston, MA, USA: Cengage Learning, 2011.
2. P. D. Sharma, *Ecology and Environment*. 10th edition, Meerut, India: Rastogi Publications, 2011.

AV1VA2: UNDERSTANDING INDIA

L	T	P	C	30L
2	0	0	2	

Prerequisites: NIL

Course Overview

The course aims to enable the students to acquire and demonstrate the knowledge and understanding of contemporary India with its historical perspective, the basic framework of the goals and policies of national development, and the constitutional obligations with special emphasis on constitutional values and fundamental rights and duties. The course would also focus on developing an understanding among students of Indian society, Indian knowledge systems and cultural heritage.

Course Objective & Outcome

The course aims at making the students understand India from global, national and local perspectives. A student would be able to understand India in geographical, historical, social, cultural and political settings. At the end of the semester, the students will be able to appreciate the multicultural and multifaceted nature of India.

Unit I: Geography of India **3**

- India on the map of the world and its neighbouring countries
- Geographical diversities

Unit II: History of India **5**

- India's Freedom Struggle
- An introduction to Indian knowledge systems

Unit III: Communicating Culture **7**

- Oral narratives: Myths, tales and folklore
- Introduction to the Tribal Cultures of India

Unit IV: Indian Social Structure **7**

- Continuity and change of the Indian Social Structure: Caste, Community, Class and Gender.

Unit V: Understanding Indian Polity **8**

- The evolution of State in India: Nature and origin
- Interpretating India: Traditional, Modern and Contemporary
- Constitution as a living document.

Reading List

Unit I: Geography of India

1. R. D. Dikshit, Political Geography: Politics of Place and Spatiality of Politics. New Delhi, India: Macmillan Education, 2020.
2. C. D. Deshpande, India: A Regional Interpretation. New Delhi, India: Indian Council of Social Science Research (ICSSR), 1992.
3. B. L. C. Johnson, Ed., Geographical Dictionary of India. New Delhi, India: Vision Books, 2001.
4. R. B. Mandal, Ed., Patterns of Regional Geography – An International Perspective, Vol. 3 – Indian Perspective, 1990.
5. R. Tirtha, Geography of India. Jaipur & New Delhi, India: Rawat Publications, 2002.
6. C. R. Pathak, Spatial Structure and Processes of Development in India. Kolkata, India: Regional Science Association, 2003.
7. R. C. Tiwari, Geography of India. Allahabad, India: Prayag Pustak Bhawan, 2007.
8. T. C. Sharma, Economic Geography of India. Jaipur, India: Rawat Publication, 2013.

Unit II: History of India

1. https://iksindia.org
2. D. M. Bose, S. N. Sen, and B. V. Subbarayappa, Eds., *A Concise History of Science in India*. New Delhi, India: Indian National Science Academy, 1971.
3. B. Chandra, A. Tripathi, and B. De, *Freedom Struggle*. New Delhi, India: National Book Trust, 1972.
4. S. A. Husain, *The National Culture of India*. New Delhi, India: National Book Trust, 2003.
5. K. Kapoor and A. K. Singh, Eds., *Indian Knowledge Systems*, 2 vols. New Delhi, India: DK Printworld, 2005.
6. B. K. Mohanta and V. K. Singh, Eds., *Traditional Knowledge System and Technology in India*. New Delhi, India: Pratibha Prakashan, 2012.
7. *History of Technology in India*, 3 vols. New Delhi, India: Indian National Science Academy, 1997-2012.
8. *The Cultural Heritage of India Series*, 8 vols. Calcutta, India: Ramakrishna Mission Institute, 2002.

Unit III: Communicating Culture

1. K. Mital, "*A Santhal Myth, Five Elements*" & M. D. Subash Chandran, "*Peasant Perception of Bhutas, Uttara Kannada*" in Prakrti, The Integral Vision, Vol. 1 (Primal Elements – The Oral Tradition, edited by B. Saraswati), pp. 119-125; 151-166.
2. A. K. Ramanujan, *"'A Flowering Tree': A Woman's Tale*," Oral Tradition, vol. 12, no. 1, pp. 226-243, 1997.
3. S. H. Blackburn, "*The Folk Hero and Class Interests in Tamil Heroic Ballads*," Asian Folklore Studies, vol. 37, no. 1, pp. 131-149, 1978.
4. B. Hauser, "*From Oral Tradition to "Folk Art": Reevaluating Bengali Scroll Paintings*," Asian Folklore Studies, vol. 61, no. 1, pp. 105-122, 2002.
5. K. Kothari, "*Myths, Tales and Folklore: Exploring the Substratum of Cinema*."

Unit IV: Indian Social Structure

1. Y. Singh, "*Caste and Class: Some Aspects of Continuity and Change*," *Sociological Bulletin*, vol. 17, no. 2, pp. 165–186, 1968. [Online]. Available: https://doi.org/10.1177/0038022919680205.

2. Y. Singh, *Modernization of Indian Tradition: A Systemic Study of Social Change*. India: Rawat Publications, 1986.
3. D. Gupta, *Interrogating caste: understanding hierarchy and difference in Indian society*. India: Penguin Books, 2000.
4. S. Rege, *Caste and Gender: The Violence Against Women in India*. Italy: European University Institute, 1996.
5. V. Xaxa, *State, Society, and Tribes: Issues in Post-colonial India*. India: Dorling Kindersley (India), licensees of Pearson Education in South Asia, 2008.
6. P. Uberoi, *Family, Kinship and Marriage in India*. India: Oxford University Press, 1994.
7. R. Robinson, *Sociology of Religion in India*. India: SAGE Publications, 2004.
8. M. N. Srinivas, *Caste: Its 20th Century Avatar*. India: Penguin Books Limited, 2000.
9. G. Jamil, *Women in Social Change*. SAGE Publishing India, 2021.
10. K. Bhasin, *Understanding Gender*, 2000.

Unit V: Understanding Indian Polity

- M. Khosla, *The Indian Constitution*. New Delhi, India: Oxford University Press, 2012.
- R. Guha, *Makers of Modern India*. Cambridge, MA, USA: The Belknap Press of Harvard University Press, 2013.
- R. Thapar, *Indian Cultures as Heritage: Contemporary Pasts*. London, UK: Seagull Books, 2021.
- V. S. Srinivasan, *The Origin Story of India's States*. Penguin Random House India Private Limited, Oct. 25, 2021.
- J. S. Deepak, *India That Is Bharat: Coloniality, Civilisation, Constitution*. New Delhi, India: Bloomsbury, 2021.

SECOND SEMESTER

AVAS122 (AV2MI2): MATHEMATICS – II

L	T	P	C	45L
3	1	0	4	

Prerequisites

- Successful completion of Mathematics I or equivalent.
- Familiarity with basic calculus, algebra, and trigonometry.
- Understanding of fundamental mathematical concepts and operations.

Course Objective

- Continue the exploration of advanced mathematical concepts beyond Mathematics I.
- Focus on calculus, differential equations, and more complex mathematical structures.
- Introduce students to vector calculus, multivariable calculus, and complex numbers.
- Enable students to solve advanced mathematical problems using various techniques.
- Develop skills for applying mathematical principles in diverse fields.

Course Outcome

- Proficiency in advanced calculus, including multivariable calculus and differential equations.
- Understanding of vector calculus, vector spaces, and applications.
- Capability to solve problems involving complex numbers and series.
- Knowledge of mathematical methods applicable in various disciplines.
- Ability to analyse, comprehend, and solve complex mathematical problems.

Unit I: Algebra **9**

Binomial, exponential and logarithmic series (without proof) – problems on summation, approximation and coefficients.

Unit II: Matrices **9**

Inverse of matrix by row transformation – Eigen values and Eigen vectors - Cayley-Hamilton theorem (without proof) – Diagonalisation – rank of matrix – solution of a general system of m linear algebraic equations in n unknown ($m \leq n$).

Unit III: **Trigonometry** **9**

Expansions for sinn θ, cosn θ, tann θ, sin (nθ), cos (nθ), tan (nθ). Exponential, circular, hyperbolic, inverse hyperbolic and logarithmic functions of a complex variable – separation of real and imaginary parts.

Unit IV: Vector Analysis **9**

Scalar fields and Vector fields – Gradient, Divergence and Curl – their properties and relations – Gauss and Stokes theorems (without proof), simple problems for their verification.

Unit V: Statistics **9**

Moments, kurtosis and skewness based on moments only. Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions. Correlation and regression – rank correlation.

TEXTBOOK

1. M. K. Venkataraman, *Engineering Mathematics* (First Year), 2nd edition, Madras, India: The National Publishing Company, 2001.
2. M. K. Venkataraman, *Engineering Mathematics* (Third Year-Part A). Madras, India: The National Publishing Company, 2001.
3. E. Kreyszig, *Advanced Engineering Mathematics*. 10th edition, U.S., John Wiley & Sons, Inc., 2011.
4. C. H. Edwards Jr. and D. E. Penney, *Differential Equations and Linear Algebra*. 4th edition, Pearson, 2021.
5. D. C. Lay, S. R. Lay, and J. J. McDonald, *Linear Algebra and Its Applications*. 4th edition, Pearson, 2020.

REFERENCE BOOKS

1. N. P. Bali and M. Goyal, *A Text Book of Engineering Mathematics*, 9th edition, Lakshmi Publications, New Delhi, 2014.
2. J. E. Marsden and A. Tromba, *Vector Calculus*, 6th edition, W.H. Freeman, New York, 2012.
3. P. M. Fitzpatrick, *Advanced Calculus*, 2nd edition, American Mathematical Society, Providence, R.I., 2009.
4. R. G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, 4th edition, Wiley, Hoboken, NJ, 2011.
5. M. Sipser, *Introduction to the Theory of Computation*. 3rd edition, Course Technology Inc., 2012.
6. E. T. Hoel, S. C. Port, and C. J. Stone, *Introduction to Probability Theory*, 1st edition, Houghton Mifflin, 1972.

Online Study Material

Websites:

- Khan Academy: Multivariable Calculus, Linear Algebra
- Paul's Online Math Notes: Calculus III, Differential Equations
- Brilliant.org: Advanced Mathematics Courses
- MIT OpenCourseWare: Mathematics Courses

Video Resources:

- YouTube channels like "Professor Leonard," "Math The Beautiful," and "Eddie Woo"
- Online platforms like Coursera, edX, and Udemy offer mathematics courses.

Practical Platforms:

- Wolfram Alpha for computational problem-solving
- Symbolab for step-by-step solutions
- Desmos for visualizing mathematical concepts

AVAS122 (AV2MI5): DATA STRUCTURES AND ALGORITHMS

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Proficiency in a programming language such as C, C++, Java, or Python.
- Basic understanding of mathematics and logic.
- Familiarity with fundamental programming concepts.

Course Objective

- Introduce fundamental data structures and their implementation.
- Teach algorithm design and analysis techniques.
- Enable students to solve computational problems efficiently.
- Focus on the optimization of algorithms and data structures.
- Prepare students for real-world applications in software development.

Course Outcome

- Understanding of various data structures such as arrays, linked lists, stacks, queues, trees, graphs, etc.
- Proficiency in algorithm design and analysis, including searching, sorting, and optimization techniques.
- Capability to implement and use data structures in practical problem-solving.
- Ability to analyse algorithm efficiency using time and space complexity.
- Skills to solve complex problems and design efficient algorithms.

Unit I: **Definition of a Data Structure** **9**

Definition of a Data structure - primitive and composite Data Types, Arrays, Operations on Arrays, Ordered lists - Stacks - Operations - Applications of Stack - Infix to Postfix Conversion.

Unit II: **Recursion** **9**

Recursion – Queue - operations - Singly Linked List – Operations - Application - Representation of a Polynomial - Polynomial Addition - Doubly Linked List - Operations.

Unit III: **Trees** **9**

Trees: Binary Trees - Operations - Graph - Definition, Types of Graphs, Graph Traversal - DFS and BFS.

Unit IV: **Algorithm Design Techniques** **9**

Basic Design and Analysis techniques of Algorithms, Correctness of Algorithm - Algorithm Design Techniques - Iterative techniques - Divide and Conquer – Dynamic Programming, Greedy Algorithms.

Unit V: **Role of Algorithms** **9**

Role of algorithms in computing - Sorting and Searching Techniques – Elementary sorting techniques –Bubble Sort, Insertion Sort, Merge Sort, Quick Sort.

TEXTBOOK

1. Ellis Horowitz, Sartaj Sahni, and Susan Anderson-Freed, *Fundamentals of Data Structures in C*, 2nd edition, Boston, MA, USA: University Press, 2008.
2. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, *Introduction to Algorithms*, 3rd edition, New Delhi, India: PHI Learning, 2009.
3. Narasimha Karumanchi, Data Structures and Algorithms Made Easy, 2nd edition, areerMonk Publications, Charleston, SC., 2012.
4. Robert Sedgewick and Kevin Wayne, *Algorithms*, 4th edition, Addison-Wesley, Boston, 2016.
5. Mark Allen Weiss, *Data Structures and Algorithm Analysis in C*, 4th edition, Pearson, Boston, 2014.
6. Steven S. Skiena, *The Algorithm Design Manual*, 3rd edition, Springer, Cham, 2020.

REFERENCE BOOKS

1. Gayle Laakmann McDowell, *Cracking the Coding Interview*, 6th ed. CareerCup, Palo Alto, CA, 2020.
2. Robert Sedgewick, *Algorithms in C++ Parts 1-4*. 3rd ed. Addison-Wesley, Reading, Mass., 1998.
3. Aaron M. Tenenbaum, Yedidyah Langsam, and Moshe J. Augenstein, *Data Structures Using C*, Prentice Hall, Englewood Cliffs, N.J., 1990.
4. Thomas H. Cormen, *Algorithms Unlocked*, The MIT Press, Cambridge, Massachusetts, 2013.
5. Adnan Aziz, Tsung-Hsien Lee, and Amit Prakash, *Elements of Programming Interviews in Python*, ElementsOfProgrammingInterviews.com, United States, 2018.

Online Study Material

Websites:

- GeeksforGeeks: Data Structures and Algorithms
- LeetCode and HackerRank for practicing problems
- Codecademy: Learn Data Structures and Algorithms
- Coursera: Data Structures and Algorithms Courses

Video Resources:

- YouTube channels like "mycodeschool," "MIT OpenCourseWare," and "Back To Back SWE"

- Platforms like Udemy, Coursera, and edX offer courses on algorithms and data structures.

Practical Platforms:

- LeetCode, CodeSignal, HackerRank, and CodeChef for practicing data structure and algorithm problems
- Visualgo for visualizing algorithms and data structures

AVAS122 (AV2MI6): PYTHON PROGRAMMING

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic knowledge of computer systems and their functioning.
- Understanding of fundamental data structures.
- Familiarity with basic concepts of information technology.

Course Objective

- To learn about the fundamentals of computers.
- To learn how to install Python, start the Python shell.
- To learn to perform basic calculations, print text on the screen and create lists,and perform simple control flow operations using if statements and for loops.
- To learn how to reuse code with functions.

Course Outcome

- Develop a foundational understanding of programming concepts such as variables, data types, operators, control structures (e.g., loops, conditionals), functions, and modules.
- Proficient in writing Python code using correct syntax and language features.
- Understanding of how to use these data structures effectively and implement algorithms using Python.
- Develop problem-solving skills by applying Python programming techniques to solve a variety of problems.
- Understand how to work with files and perform input/output operations in Python.

Unit I: **Computer Systems** **9**

Python Programming Language Computational Thinking - Python Data Types - Expressions, Variables, and Assignments – Strings – Lists – Objects & Classes – Python standard library.

Unit II: **Imperative Programming** **9**

Python modules – print() function – functional eval() - Execution Control Structures – user-defined functions python variables & assignments parameter passing.

Unit III: **Text Data, Files & Exceptions** **9**

Strings revisited – formatted output – files – errors & exceptions - Execution Control Structures – decision control & the IF statement.

Unit IV: **Container and Randomness** **9**

Dictionaries – other built-in container types – character encodings & strings – module random.

Unit V: **For Loop & Iteration Patterns** **9**

two-dimensional lists- while loop – more loop patterns – additional iteration control statements- namespaces – encapsulation in functions – global vs local namespaces exceptional flow control – modules as namespaces.

TEXTBOOK

1. L. Perkovic, *Introduction to Computing Using Python: An Application Development Focus*. Hoboken, NJ, USA: John Wiley & Sons, 2012.
2. A. Silberschatz, H. F. Korth, and S. Sudarshan, *Database System Concepts*. 4th ed. McGraw-Hill, Boston, 2002.
3. R. Elmasri and S. B. Navathe, *Fundamentals of Database Systems*. 6th ed. Pearson Education UK, 2013.
4. W. Shields, *SQL QuickStart Guide: The Simplified Beginner's Guide to Managing*, Analyzing, and Manipulating Data With SQL. ClydeBank Media LLC, Albany, 2019.
5. M. J. Hernandez, *Database Design for Mere Mortals: A Hands-On Guide to Relational Database Design.* Addison-Wesley., 1997.

REFERENCE BOOKS

1. B. Forta, *SQL in 10 Minutes*, Sams Teach Yourself. 5th ed. Sams, Hoboken, NJ, 2020.
2. A. Beaulieu, *Learning SQL: Master SQL Fundamentals*. 2nd ed. O'Reilly Media, Sebastopol, Calif., 2009.
3. R. Kimball and M. Ross, *The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling*. 3rd ed. John Wiley & Sons, 2013.
4. P. J. Sadalage and M. Fowler, *NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence*. 1st ed. Addison-Wesley Professional, 2013.
5. W. Kent, *Data and Reality: A Timeless Perspective on Perceiving & Managing Information in Our Imprecise World*. 3rd ed., Technics Publications LLC 2012.

Online Study Material

Websites:

- W3Schools: SQL Tutorial
- Tutorialspoint: DBMS Tutorial
- Oracle's LiveSQL for practicing SQL queries
- Coursera: Database Management Courses

Video Resources:

- YouTube channels like "Academind" and "The Net Ninja" for database tutorials
- Platforms like Udemy and LinkedIn Learning offer database management courses.

Practical Platforms:

- HackerRank and LeetCode for practicing SQL problems
- SQLZoo for interactive SQL practice

PYTHON PROGRAMMING LAB

Prerequisites: NIL

Program Objective

- Able to understand Syntax and Semantics and create Arrays and Functions in Python.
- Able to learn different data types Lists, and Dictionaries in Python.
- Able to know how to execute the programs using loops and control statements.
- Able to learn decision Making and Functions in Python.
- Able to know how to handle Files and exceptions in Python.

Program Outcome

After completion of the course, Students will be able to**:**

- Evaluate Problem-solving and programming capability.
- Describe the Numbers, Math functions, Strings, Lists, Tuples and Dictionaries in Python.
- Implement conditional and loop for Python programs.
- Express different Decision-Making statements, Arrays and Functions.
- Understand and summarize different File-handling operations and exceptions

List of Exercises **30**

1. Program to convert the given temperature from Fahrenheit to Celsius and vice versa depending upon the user's choice.
2. Program to calculate total marks, percentage and grade of a student. Marks obtained in each of the three subjects are to be input by the user. Assign grades according to the following criteria:

   Grade A: Percentage >=80

   Grade B: Percentage>=70 and <80

   Grade C: Percentage>=60 and <70

   Grade D: Percentage>=40 and <60

   Grade E: Percentage<40
3. Program using user-defined functions to find the area of rectangle, square,circle and triangle by accepting suitable input parameters from user.
4. Program to display the first n terms of the Fibonacci series.
5. Program to find the factorial of the given number.
6. Program to find the sum of the following series for n terms: 1 – 2/2! + 3/3! - - - - - n/n!
7. Program to calculate the sum and product of two compatible matrices.
8. Program to calculate the mass m in a chemical reaction. The mass m (in gms) disintegrates according to the formula m=60/(t+2), where t is the time in hours. Sketch a graph for t vs. m, where t >=0.
9. A population of 1000 bacteria is introduced into a nutrient medium. The population p grows as follows:

$P(t) = (15000(1+t))/(15+ e)$

where the time t is measured in hours. WAP to determine the size of the population at given time t and plot a graph for P vs t for the specified time interval.

10. Input initial velocity and acceleration, and plot the following graphs depicting equations of motion:
    I. velocity w.r.t. time (v=u+at)
    II. distance w.r.t. time (s=u*t+0.5*a*t*t)
    III. distance w.r.t. velocity (s=(v*v-u*u)/2*a)

TEXTBOOKS

1. R. Nageswara Rao, *Core Python Programming*. 3rd ed., Dreamtech Press, 2021.
2. A. B. Downey, *Think Python: How to Think Like a Computer Scientist*, 2nd ed. Updated for Python 3. Mumbai, India: Shroff/O'Reilly Publishers, 2016.

AVAS121 (AV2MJ3): ANALOG & DIGITAL ELECTRONICS

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic understanding of electrical circuits and principles.
- Familiarity with algebra, trigonometry, and basic physics.
- Proficiency in fundamental mathematics and problem-solving skills.

Course Objective

The main objectives of the course are:

- To familiarize with the principles of operation, analysis and design of pn junction diode.
- To study the construction of BJT and its characteristics in different configurations.
- To study the construction and characteristics of JFET and MOSFET.
- To study basic number systems codes and logical gates.
- To introduce the methods for simplifying Boolean expressions and design of combinational circuits.

Course Outcome

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

- Understand the principal of operation, analysis and design of pn junction diode.
- Understand the construction of BJT and its characteristics in different configurations.
- Understand the construction and characteristics of JFET and MOSFET.
- Understand basic number systems codes and logical gates.
- Understand the methods for simplifying Boolean expressions and design of combinational circuits.

Unit I: **P-N Junction Diode** **9**

Qualitative Theory of P-N Junction, P-N Junction as a diode, diode equation, volt-ampere characteristics, temperature dependence of V-I characteristics, ideal versus practical, diode equivalent circuits, Zener diode characteristics.

Unit II: **Bipolar Junction Transistor** **9**

The Junction transistor, Transistor construction, Transistor current components, Transistor as an amplifier, Input and Output characteristics of transistor in Common Base, Common Emitter, and Common collector configurations. α and β Parameters and the relation between them, BJT Specifications.

Unit III: **Field Effect Transistor** **9**

JFET-Construction, principle of Operation, Volt–Ampere characteristics, Pinch-off voltage. Small signal model of JFET. FET as Voltage Variable Resistor, Comparison of BJT and FET. MOSFET- Construction, Principle of Operation and Symbol, MOSFET characteristics in Enhancement and Depletion modes.

Unit IV: Number System and Boolean Algebra **9**

Number Systems, Base Conversion Methods, Complements of Numbers, Codes- Binary Codes, Binary Coded Decimal, Unit Distance Code, Digital Logic Gates (AND, NAND, OR, NOR, EX-OR, EX-NOR), Properties of XOR Gates, Universal Gates, Basic Theorems and Properties, Switching Functions, Canonical and Standard Form.

Unit V: Minimization Techniques **9**

The Karnaugh Map Method, Three, Four and Five Variable Maps, Prime and Essential Implications, Don't Care Map Entries, Using the Maps for Simplifying, Multilevel NAND/NOR realizations.

Combinational Circuits**:** Design procedure – Half adder, Full Adder, Half subtractor, Full subtractor, Multiplexer/Demultiplexer, decoder, encoder, Code converters, Magnitude Comparator.

TEXTBOOK

1. J. Millman and D. Halkias, *Integrated Electronics: Analog and Digital Circuits*. 2nd ed., Tata McGraw Hill Education, New Delhi, 2010.
2. S. Salivahanan and N. Sureshkumar, *Electronic Devices and Circuits*. 5th ed., New York, NY, USA: McGraw-Hill, 2022.
3. M. M. Mano, *Digital Design*, 3rd ed. New Delhi, India: Prentice Hall of India Pvt. Ltd., 2003.
4. A. S. Sedra and K. C. Smith, *Microelectronic Circuits*. 8th ed., Oxford University Press, New York, 2021.
5. R. L. Boylestad and L. Nashelsky, *Electronic Devices and Circuit Theory*. 11th ed., Pearson Education Limited, Harlow, United Kingdom, 2013.

REFERENCE BOOKS

1. K. L. Kishore, *Electronic Devices and Circuits*. 4th ed., Hyderabad, India: B. S. Publications, 2016.
2. G. S. N. Raju, *Electronic Devices and Circuits*. New Delhi, India: I.K. International Publications, 2006.
3. J. F. Wakerly, *Digital Design*, 4th ed. New Delhi, India: Pearson/PHI, 2006.
4. J. M. Yarbrough, *Digital Logic Applications and Design*. 1st ed., Cengage Learning India, 2006.
5. J. P. Uyemura, *Introduction to VLSI Circuits and Systems*. Wiley, 2006.

Online Study Material

Websites:

- All About Circuits: Electronics Tutorials
- Electronics Hub: Digital and Analog Electronics Concepts
- Falstad Circuit Simulator for hands-on circuit simulations
- MIT OpenCourseWare: Circuits and Electronics

Video Resources:

- YouTube channels like "Afrotechmods," "EEVblog," and "The Signal Path"

- Online platforms such as Coursera, Udemy, and Khan Academy offer electronics courses.

Practical Platforms:

- Tinkercad for circuit design and simulation
- CircuitVerse for building and simulating digital circuits

AV2MD2: ENERGY IN EVERYDAY LIFE

L	T	P	C	45L
3	0	0	3	

Prerequisites

- Basic understanding of electrical circuits and principles.
- Familiarity with algebra, trigonometry, and basic physics.
- Proficiency in fundamental mathematics and problem-solving skills.

Course Objective

The main objectives of the course are:

- To teach the importance of energy in life
- To sensitise the human pattern of energy consumption
- To sensitise the energy consumption and related environmental issues
- To sensitise the other possible hostile free energy technologies
- To sensitise the energy-related economic impacts

Course Outcome

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

- Understand the importance of energy
- Understand the human pattern of energy consumption Understand the energy related environmental problems
- Learn about the possible hostile-free alternative energy sources Understand the relevance between energy and economy

Unit I: **Energy** **9**

Introduction to Energy, atoms, energy - atom interaction, energy consumption, units of energy - Energy sources: solar energy, geothermal energy and nuclear energy - bioenergy - wind energy- ocean energy and fossil fuels - human patterns of energy consumption: internal consumption and external consumption, Global energy cycle.

Unit II: **Fossil Fuel and Energy Conversion Energy Sources** **9**

Fossil fuels and their types, energy content and energy potential, energy capacity measurement, energy conversion, conversion efficiency, Global potentials of fossil fuels and supply chain - origin of pollution - types of pollution and their impact on daily life - nexus between energy, environment and sustainable development.

Unit III: **Ecology and Environment** **9**

Concept and theories of ecosystems, - energy flow in natural and manmade ecosystems. Examples of natural and manmade ecosystems - agricultural, industrial and urban ecosystems - sources of pollution from energy technologies and its impact on atmosphere: air, water and soil - environmental laws on pollution control.

Unit IV: **Pollution-free Renewable Energy Technologies Solar Energy** **9**

Potential, energy conversion through photosynthesis, Photovoltaic conversion and solar thermal energy conversion. Wind Energy: potential and energy conversion systems. Ocean Energy: potential and energy conversion principles Bioenergy: resources and types.

Unit V: **Energy and Economics** **9**

Gross domestic product (GDP) and energy- energy market and society - energy efficiency - exergy - exergy and economics - energy: security- equity - environmental sustainability index and global measure.

TEXTBOOK

1. R. Loulou, J. P. Waaub, and G. Zaccour, Eds., *Energy and Environment*. New York, NY, USA: Springer, 2005.
2. R. A. Ristinen and J. J. A. Kraushaar, *Energy and the Environment*, 2nd ed. Hoboken, NJ, USA: John Wiley & Sons, 2006.
3. S. P. Sukhatme, *Solar Energy: Principles of Thermal Collection and Storage*. New Delhi, India: Tata McGraw-Hill, 1984.
4. Y. Goswami, F. Kreith, and J. F. Kreider, *Principles of Solar Engineering*. 3rd Ed., Philadelphia, PA, USA: Taylor and Francis, 2015.
5. L. L. Freris, *Wind Energy Conversion Systems*. Upper Saddle River, NJ, USA: Prentice Hall, 1990.
6. I. Sober and K. Bucher, *Geothermal Energy: From Theoretical Models to Exploration and Development*. Berlin, Germany: Springer, 2013.
7. R. H. Charlier and C. W. Finkl, *Ocean Energy: Tide and Tidal Power*. Berlin, Germany: Springer, 2010.
8. P. M. Schwarz, *Energy Economics*. Abingdon, UK: Routledge, 2018.

AV2SE2: COMPUTER PROGRAMMING LAB

L	T	P	C	45L
0	0	4	2	

Prerequisites

- Basic understanding of object-oriented programming.
- Proficiency in fundamental coding.

Course Objective

The main objectives of the course are:

- Understanding OOP Concepts**,** Programming Skills Development**,** Problem-Solving Abilities.
- Software Development Practices**,** Code Reusability and Maintainability**,** Collaboration and Teamwork**,** Debugging and Troubleshooting
- Application Development**:** oriented programming techniques, such as graphical user interfaces (GUIs), data structures, and algorithm implementation.
- Critical Thinking and Analysis**,** Adaptability and Continual Learning.

Course Outcome

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

- Understanding OOP Concepts**,** Programming Proficiency**.**
- Problem-Solving Skills: Students will demonstrate the ability to analyse programming problems, design algorithmic solutions using OOP techniques, and implement efficient and effective solutions in code.
- Code Quality and Organization**,** Software Development Practices**:** Students will apply software development practices such as version control, documentation, and testing to manage and maintain object-oriented codebases effectively.
- Collaboration and Teamwork**,** Application Development Skills**,** Debugging and Troubleshooting**,** Critical Analysis and Design**,** Continual Learning and Adaptation**.**

LIST OF EXPERIMENTS **30**

C++

1. Programs Using Functions

    - Functions with default arguments
    - Implementation of Call by Value, Call by Address and Call by Reference

2. Simple Classes for understanding objects, member functions and Constructors

    - Classes with primitive data members
    - Classes with arrays as data members
    - Classes with pointers as data members – String Class
    - Classes with constant data members
    - Classes with static member functions

3. Compile time Polymorphism

- Operator Overloading including Unary and Binary Operators.
- Function Overloading

4. Runtime Polymorphism

- Inheritance
- Virtual functions
- Virtual Base Classes
- Templates

5. File Handling

- Sequential access
- Random access

JAVA

6. Simple Java applications

- for understanding reference to an instance of a class (object), methods
- Handling Strings in Java

7. Simple Package creation.

- Developing user defined packages in Java

8. Interfaces

- Developing user-defined interfaces and implementation
- Use of predefined interfaces

9. Threading

- Creation of thread in Java applications
- Multithreading

10. Exception Handling Mechanism in Java

- Handling pre-defined exceptions
- Handling user-defined exceptions

AV2VA3: HEALTH & WELLNESS, YOGA EDUCATION, SPORTS AND FITNESS

L	T	P	C	45L
2	0	0	2	

Prerequisites: NIL

Course Objective

- Learn the principles of nutrition are all important parts of overall wellness and learn the basic concept of wellbeing.
- Demonstrate how to get healthy and stay healthy using multiple strategies.
- Identify healthy behaviors and practices that help to avoid and reduce health risks.
- Yoga education to practice mental hygiene and integrate moral values.
- Yoga education to possess emotional stability. Learn the physical fitness management.

Course Outcome

- Understand the importance of yoga, and health.
- Explore the applications of yoga and fitness.

Unit I: **Health & Wellness** **7**

Define and differentiate health and wellness - Components of health wellness and their relationship between physical activity Local, demographic, societal issues and factors affecting health and wellness.

Diet and nutrition for health & wellness - Essential components of a balanced diet for healthy living with specific reference to the role of carbohydrates, proteins, fats, vitamins & minerals - malnutrition, under nutrition and overnutrition.

Unit II: **Management of Health and Wellness** **7**

Meaning & importance of various dimensions of wellness. Relationship of physical fitness in achieving wellness. Drugs, doping and wellness. Role of diet and exercise in health management.

Unit III: **Yoga Education** **7**

Meaning and definition of yoga and its aims and objectives - Basic principles of yoga and its importance in our daily life - Yoga for mental attitude - Mind, body, breath and emotional level for higher plan of living.

Unit IV: **Yoga Practices** **7**

Types and limbs of yoga Yoga postures - Asana - Breathing Practices - Pranayama - Relaxation-Meditation - Mudra.

Unit V: **Fitness Activities** **7**

Types of fitness activities - Outdoor activities - Basic movement patterns. Indoor activity-Aerobics/Dance Fitness, Resistance Training for Fitness.

TEXTBOOK

1. C. Bouchard, S. N. Blair, and W. L. Haskell, *Physical Activity and Health*. 2nd ed., U.S.: Human Kinetics, Inc., 2012.
2. E. Attached and M. Fernandez, *Mental Health Workbook*, 2021.
3. N. Lorick, *Mental Health Workbook for Women: Exercises to Transform Negative Thoughts and Improve Well Being*, 2022.
4. C. Nyambichu and J. Lumiri, *Lifestyle Diseases: Lifestyle Disease Management*, 2018.
5. A. Clow and S. Edmunds, *Physical Activity and Mental Health*, 2013.
6. B. Keane, *The Fitness Mindset*.
7. *Yoga RX: A Step-by-Step Program to Promote Health, Wellness, and Healing for Common Ailments*.
8. *Advanced Hatha Yoga: Classic Methods of Physical Education and Concentration*, 1st ed.
9. National Council of Educational Research and Training (NCERT), *Yoga and Physical Education*. India.
10. C. A. Bucher, *Administration of Health and Physical Education Programme*.
11. B. N. Ghosh, *Treaties of Hygiene and Public Health*.
12. J. J. Hanlon, *Principles of Public Health Administration*, 2003.
13. C. E. Turner, *The School Health and Health Education*.
14. National Education Association of U.T.A., *Health Education*.
15. Harber and Brothers, *The School Health Education*. New York, NY, USA.
16. D. C. S. James, Ed., *Nutrition Encyclopedia*. Farmington Hills, MI, USA: The Gale Group, Inc.
17. S. Boyd-Eaton *et al*., *The Stone Age Health Programme: Diet and Exercise as Nature Intended*, 1989.
18. T. S. Thorons, *Stress, How Your Diet Can Help: The Practical Guide to Positive Health Using Diet, Vitamins, Minerals, Herbs and Amino Acids*, 1994.

AV2VA4: DIGITAL TECHNOLOGIES

L	T	P	C	45L
1	0	2	2	

Prerequisites: NIL

Course Objective

- Well-rounded understanding of digital technologies and their applications, empowering them to thrive in an increasingly digital and interconnected world.
- Introduce students to digital technologies
- Enable students to solve advanced electronics problems using various techniques.
- Develop skills for applying basic principles in diverse fields.

Course Outcome

- Understand the importance of digital technology, digital financial tools, e-commerce.
- Analyse the concepts of communication and networks.
- Understand the e-governance and Digital India initiatives.
- Understand the use & applications of digital technology.
- Explore the applications of machine learning and big data.

Unit I: **Introduction & Evolution of Digital Systems** **7**

Role & Significance of Digital Technology. Information & Communication Technology & Tools. Computer System & its working, Software and its types. Operating Systems: Types and Functions. Problem Solving: Algorithms and Flowcharts.

Unit II: **Communication Systems** **7**

Principles, Model & Transmission Media. Computer Networks & Internet: Concepts & Applications, WWW, Web Browsers, Search Engines, Messaging, Email, Social Networking. Computer Based Information System: Significance & Types. Ecommerce & Digital Marketing: Basic Concepts, Benefits & Challenges.

Unit III: **Digital India & e-Governance** **7**

Initiatives, Infrastructure, Services and Empowerment. Digital Financial Tools: Unified Payment Interface, Aadhar Enabled Payment System, USSD, Credit / Debit Cards, e-wallets, Internet Banking, NEFT/RTGS and IMPS, Online Bill Payments and PoS. Cyber Security: Threats, Significance, Challenges, Precautions, Safety Measures, & Tools, legal and ethical perspectives.

Unit IV: **Emerging Technologies & Their Applications- I** **7**

Overview of Cloud Computing, Big Data, Internet of Things, Virtual Reality.

Unit V: Emerging Technologies & Their Applications- II **7**

Blockchain & Cryptocurrency, Robotics, Machine Learning & Artificial Intelligence, 3- D Printing. Digital Signatures.

PRACTICAL COMPONENT

List of experiments **10**

1. Operating System Installation and Configuration
2. Application Software Installation and configuration
3. Hardware understanding and minor troubleshooting
4. Networking, cabling, configuration

TEXTBOOK

1. P. Kumar, A. Tomar, and R. Sharmila, *Emerging Technologies in Computing - Theory, Practice, and Advances*, 1st ed. Boca Raton, FL, USA: Chapman and Hall/CRC, 2021. eBook ISBN: 9781003121466. Available: https://doi.org/10.1201/9781003121466
2. V. Rajaraman, *Introduction to Information Technology*, 3rd ed. New Delhi, India: PHI, 2018. ISBN: 978-9387472297.
3. E. Balagurusamy, *Fundamentals of Computers*, 2nd ed. New Delhi, India: Tata McGraw-Hill, 2011. ISBN: 9780071077880.
4. B. A. Forouzan, *Data Communications and Networking*, 4th ed. New York, NY, USA: McGraw Hill, 2007. ISBN: 978-0-07-296775-3.

REFERENCE BOOK

1. R. Buvya, J. Broberg, and A. Gosciniski, *Cloud Computing: Principles and Paradigms*. Hoboken, NJ, USA: Wiley, 2011. ISBN: 978-0-470-88799-8.
2. S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 3rd ed. Upper Saddle River, NJ, USA: Pearson Education, 2010. ISBN: 978-0-13-604259-4.
3. S. Greengard, *Internet of Things*. Cambridge, MA, USA: The MIT Press, 2015. ISBN: 9780262328937. [Online]. Available: https://doi.org/10.7551/mitpress/10277.001.0001
4. C. S. V. Murthy, *E-Commerce: Concepts, Models & Strategies*. Mumbai, India: Himalaya Publishing House, 2015. ISBN: 8178662760.
5. H. Hurwitz, T. Nugent, J. Halper, and M. Kaufman, *Big Data for Dummies*, 1st ed. Hoboken, NJ, USA: Wiley & Sons, 2013. ISBN: 978-1118504222.

Online Study Material

Websites:

- Khan Academy: Multivariable Calculus, Linear Algebra
- Paul's Online Math Notes: Calculus III, Differential Equations
- Brilliant.org: Advanced Mathematics Courses
- MIT OpenCourseWare: Mathematics Courses

Video Resources:

- YouTube channels like "Professor Leonard," "Math The Beautiful," and "Eddie Woo"
- Online platforms like Coursera, edX, and Udemy offer mathematics courses.

Practical Platforms:

- Wolfram Alpha for computational problem-solving

- Symbolab for step-by-step solutions
- Desmos for visualizing mathematical concepts

THIRD SEMESTER

AVAS231 (AV3MJ4): INTRODUCTION TO VEHICLE SYSTEMS

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic knowledge of physics and mathematics.
- Understanding of engineering principles.
- Familiarity with basic concepts of aerodynamics and hydrodynamics.

Course Objective

- Introduce the fundamental principles of aerospace and submarine systems.
- Teach the basics of aerodynamics and hydrodynamics applied in these systems.
- Explore the design, functions, and operation of aircraft, spacecraft, and submarines.
- Focus on key components and their integration in these systems.
- Enable students to comprehend the challenges and innovations in these fields.

Course Outcome

- Understanding Vehicle Dynamics
- System Integration and Control
- Electrical and Electronic Systems

Unit I: **History of Flight** **9**

Balloon flight- ornithopers -Early Airplanes by the Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

Aircraft Configurations and Its Controls: Different types of flight vehicles, classifications-Components of an aeroplane and their functions Conventional control, powered control-Basic instruments for flying-Typical systems for control actuation.

Basics of Aerodynamics: Physical Properties and Structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Airfoils, Mach number, Maneuvers.

Unit II: **Basics of Aircraft Structures** **9**

General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains- Hooke's law-stress-strain diagrams elastic constants- factor of Safety.

Unit III: Introduction To Sea Keeping **9**

Importance of seakeeping analysis. The behaviour of a ship in a seaway. Regular waves, Sinusoidal and trochoidal Theories. Characteristics of waves; Sea surface. Analytical and statistical representations. Descriptive characterization of the sea. Average and significant wave heights. Wave histogram. Characterization by energy spectrum. Standard sea spectra. Beaufort scale.

Unit IV: **Stabilization of Ship Motions** **9**

Roll stabilisers- Bilge keels, Gyroscopic stabilisers, Movement of weight, Rudder action, Jet flaps, Stabilizing fins, Passive and Active tank stabilizers**.** Pitch stabilization methods: Ship motion experiments. Generation of Regular and Irregular waves. Captive and free-running model tests. Full-scale Tests. Design considerations for seakeeping. Seakeeping criteria. ITTC Guidelines. Effect of design parameters and hull form on seakeeping.

Unit V: Introduction to Manoeuvrability **9**

Controlled and uncontrolled motions. Control Loop. Course keeping. Motion stability of ocean vehicles. Equations of motion. Hydrodynamic derivations. Stability criterion. Course changing. Tuning circle, zigzag and spiral manoeuvers. Heel while turning. Manoeuvring trials.

Control Surfaces: Control surface geometry. Rudders- types and characteristics. Effect of stall, aeration and cavitation. (Flow around rudder, Influence of ship- features on controls fired stability.) Design of rudders. Calculation of steering gear torque. Bending moment and stresses in rudder stock. Structural design of rudders. Other manoeuvring devices. Maneuvering in restricted waters.

TEXTBOOK

1. J. D. Anderson, *Introduction to Flight*, 8th ed. New York, NY, USA: McGraw-Hill, 2015.
2. A. C. Kermode, *Flight Without Formulae*, 11th ed. New Delhi, India: Pearson Education, 2011.
3. S. Corda, *Introduction to Aerospace Engineering with a Flight Test Perspective*. Hoboken, NJ, USA: Wiley, 2023.
4. E. L. Houghton and P. W. Carpenter, *Aerodynamics for Engineering Students*. Oxford, UK: Butterworth-Heinemann, 2023.
5. H. S. Levie, *Submarine Design and Engineering*. Annapolis, MD, USA: Naval Institute Press, 2023.
6. E. C. Tupper, *Introduction to Naval Architecture*. Oxford, UK: Butterworth-Heinemann, 2023.

REFERENCE BOOKS

1. R. Bhattacharya, Dynamics of Marine Vehicles.
2. V. Lewis, Ed., Principles of Naval Architecture, vol. III. Jersey City, NJ, USA: The Society of Naval Architects and Marine Engineers.
3. D. P. Raymer, Aerospace Propulsion.
4. D. P. Raymer, Aircraft Design: A Conceptual Approach.
5. T. J. Mallick, Fundamentals of Submarine Design.
6. S. Wilkinson, Fluid Mechanics for Marine Ecologists and Oceanographers.
7. G. L. Harrell, Introduction to the Design and Analysis of Composite Structures: An Engineer's Practical Guide Using OptiStruct.

Online Study Material

Websites:

- NASA's Beginner's Guide to Aerodynamics
- Aerospace Engineering Courses on Coursera
- Submarine Technology - Naval Technology
- Khan Academy: Fluid Dynamics

Video Resources:

- YouTube channels like "Engineering Explained" and "SmarterEveryDay"
- Online platforms such as Udemy and edX offering aerospace-related courses.

Practical Platforms:

- Access to case studies and research papers in aerospace and submarine technology.
- Virtual simulations or online resources offered by institutions or research facilities for practical understanding.

INTRODUCTION TO VEHICLES SYSTEMS LAB

List of Exercises **30**

1. Smoke visualization over cylinder and airfoil section to show boundary layer separation.
2. To acquaint with aircraft fuselage constructional details and types.
3. Study off Fuselage structure i.e., longerons, bulk head stringes etc.
4. To acquaint with aircraft wing constructional details and types.
5. To acquaint with aircraft primary control surfaces along with their locations on aircraft.
6. To acquaint with aircraft secondary flight control surfaces along with their locations on aircraft
7. Study of Piston engine and its components like cylinder block, piston, camshaft, crank-shaft, piston rod, valves etc.
8. Study of Jet Engine and its components like inlet, compressors, combustion chambers, turbine exhaust cone etc.
9. To acquaint with different types of Jet Engine e.g., turbojet, turboprop, turboshaft etc.
10. Study of ship parts and control surfaces.
11. Tension test - metals and composites
12. Compression Test – metals and composites
13. Hardness test: Rockwell and Brinell
14. Ductility test: Sheet metals (Al, GI and MS).
15. Impact Test

AVAS232 (AV3MJ5): STRENGTH OF MATERIALS

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic knowledge of physics and mathematics, including calculus and algebra.
- Understanding of fundamental engineering mechanics concepts.
- Familiarity with forces, stress, and strain.

Course Objective

- Introduce the fundamental principles of solid mechanics.
- Teach the behaviour of solids under various loading conditions.
- Explore stress, strain, and material properties related to solids.
- Enable students to analyse and design solid structures.
- Focus on practical applications and problem-solving in solid mechanics.

Course Outcome

- Understanding of stress, strain, and deformation in solid materials.
- Proficiency in analysing structural behaviour under different loading conditions.
- Capability to solve problems related to the strength of materials.
- Ability to design basic structures and components using solid mechanics principles.
- Skills to apply theoretical concepts to practical engineering problems.

Unit I: **Simple Stresses and Strain** **9**

Relation between three modulus and Poisson's ratio – Thermal Stress – Principal stress and Principal planes - Shear Force – Bending Moment – Cantilever and simply supported beams subjected to point loads and uniformly distributed loads.

Unit II: **Bending - Stress** **9**

Theory of simple bending - stress variation in beam cross Section; Normal and Shear stress in Beams – Beam of uniform strength for bending, combined direct and bending stresses.

Unit III: **Double Integration Method** **9**

Moment area method – Introduction to strain energy method and Principle of virtual work.

Unit IV: **Torsion** **9**

Torsion of circular solid and hollow shafts, Shafts in Series and parallel, Combined bending and torsion -Application of Torsion in helical springs: Open and closed coil springs, Leaf Springs.

Unit V: **Euler's Equation** **9**

Short and long column, Empirical formulae: Johnson – Rankine. Introduction to thin cylinder – Thick cylinder – Lame's Equation – Compound Cylinders – Interference fit.

TEXTBOOK

1. R. K. Bansal, *Strength of Materials*, 4th ed. New Delhi, India: Laxmi Publications, 2007.
2. S. S. Bhavikatti, *Strength of Materials*, 2nd ed. New Delhi, India: Vikas Publishing House, 2002.
3. F. P. Beer, E. R. Johnston Jr., J. DeWolf, and D. Mazurek, *Mechanics of Materials*. 8th ed. New York, NY, USA: McGraw-Hill, 2020s.
4. R. K. Bansal, *Strength of Materials*. 6th ed. New Delhi, India: Laxmi Publications, 2018.
5. D. W. A. Rees, *Mechanics of Solids and Structures*. 2nd ed. Hoboken, NJ, USA: Wiley, 2016.

REFERENCE BOOKS

1. U. G. Jindal, *Strength of Materials*. 2nd ed. New Delhi, India: Galgotia Publication Pvt. Ltd., 2017.
2. R. K. Rajput, *Strength of Materials*. 6th ed. New Delhi, India: S. Chand and Company Ltd., 2015.
3. E. P. Popov, *Engineering Mechanics of Solids*. 2nd ed. Upper Saddle River, NJ, USA: Prentice Hall, 1988.
4. L. Anand and S. Govindjee, *Fundamentals of Solid Mechanics*. Cambridge, UK: Cambridge University Press.
5. W. M. Lai, D. Rubin, and E. Krempl, *Introduction to Continuum Mechanics*. Amsterdam, Netherlands: Elsevier, 1974.
6. R. C. Hibbeler, Engineering Mechanics: *Statics and Dynamics*. 15th ed. Upper Saddle River, NJ, USA: Pearson/Prentice Hall, 2024.

Online Study Material

Websites:

- Mechanics of Materials Tutorials on Engineering Funda
- MIT OpenCourseWare: Mechanics of Solids
- Engineering Mechanics and Solid Mechanics on NPTEL
- Interactive online tutorials on Coursera and Khan Academy

Video Resources:

- YouTube channels like "Jeff Hanson" and "Structure Free"
- Platforms such as Coursera, edX, and Udemy offer courses on Mechanics of Solids.

Additional Resources:

- Utilize software for simulation and visualization of stress and strain.
- Access to academic papers and research in the field of solid mechanics for deeper understanding.

STRENGTH OF MATERIALS LAB

Program Objective

- Become familiar with the basic types of mechanical tests, including tests in tension, indentation hardness, notch impact, bending, and torsion.
- Analyse data from tension tests to determine materials properties, including both engineering properties and true stress-strain properties.
- Understand the significance of the properties obtained from basic mechanical tests, and explore some of the major trends in behaviour that are seen in these tests.

Program Outcome

- Conduct Tension, Compression, Bending & Shear tests on UTM and evaluate material properties.
- Conduct Torsion, Hardness & Impact tests and determine various moduli, hardness numbers and impact energy.

List of Exercises **30**

1. Tension test - metals and composites
2. Compression Test – metals and composites
3. Hardness test: Rockwell and Brinell
4. Ductility test: Sheet metals (Al, GI and MS).
5. Impact Test
6. Deflection test on Cantilever beam
7. Deflection test on simply supported beam
8. Torsion test
9. Spring test
10. Compression test on wood or concrete,
11. Shear test
12. Verification of Maxwell’s reciprocal theorem on beams
13. Use of electrical resistance strain gauge
14. Deflection test on Continuous beam

AV3MD3: INTRODUCTION TO PUBLIC ADMINISTRATION

L	T	P	C	45L
3	0	0	3	

Prerequisites

- Basic knowledge of public administration.

Course Objective

- This course introduces the students to the elements of public administration. This would help them obtain a suitable conceptual perspective on Public Administration.
- In addition, the course introduces to students, the growth of such institutional devices as to meet the need of changing times.
- The course also aims to instil and emphasize the need for ethical seriousness in contemporary Indian public administration within the Constitutional framework.

Course Outcome

- Understanding of the fundamental concepts and principles of fluid mechanics.
- Proficiency in analysing fluid flow, pressure, and velocity distributions.
- Capability to solve problems related to static and dynamic fluid behaviors.
- Ability to analyse and discuss different types of fluid flows and their applications.
- Skills to apply theoretical concepts to practical engineering problems.

Unit I: Introduction **10**

Meaning, nature and Scope of Public Administration and its relationship with other disciplines- Evolution of Public Administration as a discipline – Woodrow Wilson, Henry Fayol, Max Weber and others - Evolution of Public Administration in India – Arthashastra – Colonial Administration up to 1947.

Unit II: **Public Administration in India** **10**

Enactment of Indian Constitution - Union Government – The Cabinet – Central Secretariat - All India Services – Training of Civil Servants – UPSC – Niti Ayog – Statutory Bodies: The Central Vigilance Commission – CBI - National Human Rights Commission – National Women's Commission –CAG.

Unit III: **State and Union Territory Administration** **12**

Differential Administrative systems in Union Territories compared to States Organization of Secretariat: -Position of Chief Secretary, Functions and Structure of Departments, Directorates – Ministry of Home Affairs supervision of Union Territory Administration – Position of Lt. Governor in UT – Government of Union Territories Act 1963 – Changing trend in UT Administration in Puducherry and Andaman and Nicobar Island.

Unit IV: **Emerging Issues in Indian Public Administration** **13**

Changing Role of District Collector – Civil Servants – Politicians relationship – Citizens Charter - Public Grievance Reddressal mechanisms — The RTI Act 2005 – Social Auditing and Decentralization – Public-Private partnership.

STUDY MATERIALS

1. A. R. Tyagi, *Public Administration*. New Delhi, India: Atma Ram Sons, 1983.
2. P. H. Appleby, *Policy and Administration*. Alabama, USA: The University of Alabama Press, 1949.
3. Avasthi and Maheswari, *Public Administration in India*. Agra, India: Lakshmi Narain Agarwal, 2013.
4. G. E. Caden, *Public Administration*. California, USA: Pablidas Publishers, 1982.
5. Central Information Commission, "*Central Information Commission*,". Available: http://cic.gov.in/
6. Ministry of Home Affairs, "*Ministry of Home Affairs*," [Online]. Available: http://www.mha.nic.in/
7. Right to Information, "*Right to Information*," [Online]. Available: http://rti.gov.in/
8. Central Vigilance Commission, "Central Vigilance Commission,". Available: http://www.cvc.nic.in/
9. R. B. Jain, *Public Administration in India: 21st Century Challenges for Good Governance*. New Delhi, India: Deep and Deep, 2002.
10. R. K. Arora, *Indian Public Administration*. New Delhi, India: Wishwa Prakashan, Sterling, 2013.

AVAS233 (AV3MI7): INTRODUCTION TO MICROPROCESSORS AND MICROCONTROLLERS

L	T	P	C	45L
3	1	0	4	

Prerequisites

- Basic knowledge of digital electronics and computer architecture.
- Familiarity with fundamental electrical circuits and components.
- Understanding of programming concepts.

Course Objective

- Introduce the architecture, working principles, and applications of microprocessors and microcontrollers.
- Teach the programming, interfacing, and applications of microprocessors and microcontrollers.
- Explore the hardware and software aspects, including assembly language programming.
- Enable students to design, implement, and troubleshoot microcontroller-based systems.
- Provide hands-on experience through practical projects.

Course Outcome

- Understanding of microprocessor and microcontroller architecture.
- Proficiency in programming and interfacing microprocessors and microcontrollers.
- Capability to design and implement microcontroller-based systems.
- Ability to troubleshoot and debug microcontroller-based systems.
- Skills to apply learned concepts in practical projects.

Unit I: 8085 Microprocessor **9**

Computer and its organization - Programming System - Microprocessor: Address, data, control and Tristate bus, connecting microprocessor to I/O Devices – Evolution of Microprocessor: 8-bit and 16 Microprocessors – 8085 Hardware architecture: 8085 clock, Programmable registers, address and data busses, memory interfacing, Interrupt system, DMA, Serial I/O – 8085 pin out – 8085 Instruction set: Status word, Instruction format, addressing modes, instruction set.

Unit II: Microprocessor Peripheral Interfacing **9**

Programmable Peripheral interface 8255 – Keyboard and display interface – Programmable timer 8253 and 8254. 8086 Hardware Architecture: Architecture – 8086 system configurations.

Unit III: Microcontrollers **9**

Microcontrollers and embedded processors – Overview of 8051 family – Inside the 8051 - 8051 Assembly programming – 8051 I/O programming – Addressing modes. The PIC Microcontrollers: History and Features - PIC Architecture & Assembly Language Programming - PIC Programming in C.

Unit IV: Microcontroller Peripheral Programming **9**

8051 Hardware connection and Intel HEX file – 8051 Timer programming in C – 8051 Serial port programming in C – 8051 Interrupts programming in C. PIC18 Timer Programming in Assembly and C - PIC18 Serial Port Programming in Assembly and C.

Unit V: 8051 Microcontroller Based Systems Design **9**

LCD and keyboard interfacing – ADC, DAC, and sensor interfacing - RTC interfacing – Motor control: Relay, PWM, DC and Stepper motor interfacing.

TEXTBOOK

1. K. Kant, *Microprocessors and Microcontrollers*. New Delhi, India: PHI Learning Private Limited, 2007.
2. M. A. Mazidi and J. G. Mazidi, *The 8051 Microcontroller and Embedded Systems*. New Delhi, India: PHI Learning, 2002.
3. M. A. Mazidi, R. McKinlay, and D. Causey, *PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC 18*. 2nd ed. New York, NY, USA: Pearson Education, 2021.
4. R. S. Gaonkar, *Microprocessor Architecture, Programming, and Applications with the 8085*. 6th ed. India: Penram International Publishing, 2013.
5. A. Sloss, D. Symes, and C. Wright, *ARM System Developer's Guide: Designing and Optimizing System Software*. Boston, MA, USA: Morgan Kaufmann, 2004.

REFERENCE BOOKS

1. J. B. Peatman, *Design with PIC Microcontrollers*. 1st ed. Pearson Education Asia, 1998.
2. K. J. Ayala, The 8051 Microcontroller: Architecture, Programming, and Applications. 2nd ed. Penram International Publishing (India), 1996.
3. E. Balagurusamy, *Programming in ANSI C*, 8th ed. New Delhi, India: Tata McGraw-Hill, 2019.
4. R. Kamal, *Embedded Systems: Architecture, Programming and Design*. 3rd ed. India: McGraw Hill Education, 2017.
5. K. J. Ayala, *The 8051 Microcontroller*. 3rd ed. Delmar Cengage Learning, 2004.
6. W. Hohl, *ARM Assembly Language: Fundamentals and Techniques*. 2nd ed. CRC Press, 2014.

Online Study Material

Websites:

- Microcontroller Tutorials on Electronics Hub
- 8051 Microcontroller and PIC Microcontroller Resources on Circuit Digest
- Embedded Systems Basics on Learn Embedded Systems
- Microprocessor and Microcontroller - Studytonight

Video Resources:

- YouTube channels like "MikroElektronika," "The Engineering Projects," and "Simple Labs"

- Platforms like Udemy, Coursera, and edX offer courses on microprocessors and microcontrollers.

Additional Resources:

- Online simulators for microcontroller programming and simulation.
- Practical DIY kits and development boards for hands-on learning.

AVAS233 (AV3MI8): MATHEMATICS – III

L	T	P	C	45L
3	1	0	4	

Prerequisites

- Successful completion of Mathematics I and Mathematics II courses or equivalent.
- Solid understanding of calculus, differential equations, linear algebra, and multivariable calculus.
- Proficiency in mathematical analysis, probability, and statistics.

Course Objective

- Introduce advanced mathematical concepts beyond Mathematics II.
- Focus on complex analysis, numerical methods, and further applications of calculus.
- Explore mathematical methods in engineering, physics, and other scientific disciplines.
- Enable students to apply advanced mathematical techniques to solve real-world problems.
- Lay a strong foundation for more specialized mathematical fields.

Course Outcome

- Understanding of complex analysis and its applications in mathematics and physics.
- Proficiency in numerical methods, including approximation and iterative techniques.
- Capability to solve partial differential equations and apply methods in engineering problems.
- Ability to use mathematical techniques in diverse scientific and engineering contexts.
- Preparation for more specialized fields of mathematics and scientific disciplines.

Unit I: **Laplace Transform** **9**

Definitions – Laplace transform of unit impulse and step functions – Laplace transform of periodic functions – Exponential shift formula – Initial and final value theorems – Laplace transform of derivatives and integrals – Convolution theorem – Inverse Laplace transform – Methods of determining inverse Laplace transform – Solution of linear differential equations using Laplace transforms.

Unit II: **Function of a Complex Variable** **9**

Functions of a complex variable – continuity, derivative and analytic function – Cauchy-Reimann equations – Necessary and sufficient conditions for analyticity – Harmonic and orthogonal properties of real and imaginary parts – Conformal mapping – Bilinear transformations.

Unit III: **Complex Integration** **9**

Cauchy's theorem – Cauchy's integral formula – Taylor's and Laurent series – Residue theorem- Contour integration round the unit circle and semicircular contour.

Unit IV: Fourier Series **9**

Dirichlet's conditions – Expansion of periodic functions into Fourier series – Change of interval – Half range Fourier series. Complex form of Fourier series – Root mean square value – Parseval's theorem on Fourier coefficients – Harmonic analysis.

Unit V: **Fourier Transform** **9**

Fourier integral (statement only), Fourier transform, Inverse Fourier transform, Fourier sine and Cosine transforms, definitions and properties.

TEXTBOOK

1. M. K. Venkataraman, *Engineering Mathematics*, Vol. II. Madras, India: National Publishing Co., 2009.
2. M. K. Venkataraman, *Engineering Mathematics*, Vol. III. Madras, India: National Publishing Co., 2009.
3. E. Kreyszig, *Advanced Engineering Mathematics*. 10th ed. U.S., John Wiley & Sons, Inc., 2011.
4. J. W. Brown and R. V. Churchill, *Complex Variables and Applications*. ; 9th ed. McGraw Hill Higher Education, 2013.
5. S. C. Chapra and R. P. Canale, *Numerical Methods for Engineers*. 5th ed. New Delhi, India: Tata McGraw hill edu. Pvt. Ltd, 2007

REFERENCE BOOKS

1. N. P. Bali and Manish Goyal, *A Textbook of Engineering Mathematics*. 9th ed. New Delhi, India: Laxmi Publications, 2016.
2. B. S. Grewal, *Higher Engineering Mathematics*. New Delhi, India: Khanna Publishers, 2008.
3. D. Zill and P. Shanahan, *A First Course in Complex Analysis with Applications*. 3rd ed. Jones and Bartlett Publishers, Inc, 2013.
4. W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, *Numerical Recipes: The Art of Scientific Computing*. 3rd ed. Cambridge University Press, 2007.
5. D. Borthwick, *Introduction to Partial Differential Equations*. 1st ed. Springer International Publishing, Cham, 2016.

Online Study Material

Websites:

- MIT OpenCourseWare: Mathematics III courses
- Khan Academy: Complex Numbers and Complex Variables
- Numerical Methods Tutorials on MathWorks
- Coursera: Advanced Mathematics Courses

Video Resources:

- YouTube channels like "Eddie Woo," "MathTheBeautiful," and "The Math Sorcerer"
- Platforms such as Coursera, Udemy, and edX offer mathematics courses.

Practical Platforms:

- MATLAB, Python libraries, and specialized software for numerical and complex analysis.
- Problem sets and exercises available on various educational platforms.

AVAS233 (AV3MI9): RENEWABLE ENERGY SOURCES AND APPLICATIONS

L	T	P	C	45L
3	1	0	4	

Prerequisites

- Basic understanding of physics and environmental sciences.
- Familiarity with energy systems and sustainability concepts.
- Fundamental knowledge of engineering and technology.

Course Objective

- Introduce the basic principles of renewable energy sources.
- Explore various renewable energy technologies and their applications.
- Teach the advantages, challenges, and feasibility of renewable energy sources.
- Focus on environmental impact and sustainability in energy production.
- Enable students to analyse, design, and discuss renewable energy systems.
- To know the fundamentals of Energy Resources & Environmental Impact.

Course Outcome

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

- Understanding of various renewable energy sources such as solar, wind, hydro, biomass, geothermal, etc.
- Proficiency in assessing the potential and limitations of different renewable energy technologies.
- Capability to evaluate economic, environmental, and social aspects of renewable energy systems.
- Ability to analyse and design basic renewable energy systems.
- Skills to discuss and promote the integration of renewable energy sources in energy systems.

Unit I: **Energy Resources & Environmental Impact** **9**

Introduction to the nexus between energy, environmental sustainable development, Energy sources overview and classification, sun as the source of energy, fossil fuel reserves and resources-overview of global/India's energy scenario. Energy consumption models–Specific Energy Consumption.

Unit II: **Solar Energy** **9**

Solar radiation: measurements and prediction. Indian's solar energy potential and challenges, solar energy conversion principles and technologies: Photosynthesis, Photovoltaic conversion and Photothermal energy conversion.

Unit III: **Wind Energy** **9**

Atmospheric circulations, atmospheric boundary layers, classification, factors influencing wind, wind shear, turbulence, wind energy basics and power Content, wind speed monitoring, Betz limit, wind energy conversion system: classification, characteristics and applications.

Unit IV: Bioenergy **9**

Biomass as energy resources; bio-energy potential and challenges, Classification and estimation of biomass; Source and characteristics of biofuels: Biodiesel, Bioethanol, Biogas. Types of biomass energy conversion systems-waste to energy conversion technologies.

Unit V: Renewable Energy Conversion Techniques **9**

Thermochemical Conversion -Basic aspects of biomass combustion - heat of combustion - different types of grates - Co combustion of biomass – Gasification - Fixed and Fluidized bed gasifier - Gasification technologies for the selected waste like Rice Husk, Coir pith, Bagasse, Poultry litter etc., Pyrolysis.

TEXTBOOK

1. R. Loulou, J. P. Waaub, and G. Zaccour, Eds., *Energy and Environment Set: Mathematics of Decision Making*, Springer-Verlag New York Inc., 2005.
2. R. A. Ristinen, J. J. A. Kraushaar, and J. P. Ristinen, *Energy and the Environment*, 2nd ed. Hoboken, NJ, USA: John Wiley, 2006.
3. G. Boyle, *Renewable Energy: Power for a Sustainable Future*. 3rd ed., Oxford University Press, 2012.
4. F. Kreith and J. F. Kreider, *Principles of Sustainable Energy Systems*. 3rd ed., CRC Press, 2018.
5. V. Nelson, *Introduction to Renewable Energy*. 2nd ed., CRC Press, 2016.

REFERENCE BOOKS

1. S. P. Sukhatme, *Solar Energy: Principles of Thermal Collection and Storage*. New Delhi, India: Tata McGraw-Hill, 1984.
2. L. L. Freris, *Wind Energy Conversion Systems*. Upper Saddle River, NJ, USA: Prentice Hall, 1990.
3. H. Lund, *Renewable Energy Systems*. Academic Press Inc., 2009.
4. L. E. Jones, *Renewable Energy Integration: Practical Management of Variability, Uncertainty, and Flexibility in Power Grids*. 2nd ed., Academic Press Inc., 2017.

Online Study Material

Websites:

- Renewable Energy Resources on the National Renewable Energy Laboratory (NREL) website
- Renewable Energy Tutorials on Energy.gov
- Khan Academy: Sustainable Energy Courses
- Renewable Energy Courses on Coursera and edX

Video Resources:

- YouTube channels like "Fully Charged" and "Renewable Energy World"
- Online platforms such as Coursera, Udemy, and FutureLearn offer courses on renewable energy.

Practical Platforms:

- Access to research papers, articles, and case studies in the field of renewable energy.
- Utilize tools for energy analysis, simulation, and modelling.

AV3SE2: MICROPROCESSORS AND MICROCONTROLLERS LAB

List of Exercises **30**

1. Using 8085 kits and writing program in Assembly
    a. Simulation of number: Write a program to find the sum of n numbers
    b. Sorting of number
2. Write a program to find the largest/smallest number in an array of numbers Using 8051 microcontroller kit and writing program in C
    a. Counter Design
3. Display digits starting from 00 up to 99, incremented every second
    b. Lamp Controller
4. Switch ON a lamp through a relay and switch it OFF after say 2 minutes under p program control
    a. Water Level Indicator
5. Sense the presence or absence of water and switch ON or OFF an LED.
6. DAC Interface
    a. Interface DAC to the microcontroller to generate a saw-tooth, square and triangular waveform,
7. STEPPER MOTOR INTERFACE: Interface to a Stepper motor to rotate.
8. LCD Interface: Interface an 16 x 2 LCD display
    a. Hello World
    b. Controlling a Relay
    c. LED Bar Graph Display
    d. Playing Music
    e. Simple Counter
    f. Measuring Temperature by Thermistor
    g. IR Remote Controller
    h. 3-axis Accelerometer
    i. Controlling DC motor, Stepper Motor and Servo Motor
    j. DC motors Torque/Speed Control
    k. Control the Velocity of the Joints

FOURTH SEMESTER

AVAS241 (AV4MJ6): FLUIDS MECHANICS

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic knowledge of physics, including Newtonian mechanics.
- Familiarity with calculus and differential equations.
- Understanding of fundamental concepts of fluid mechanics and properties.

Course Objective

- Introduce the principles and behaviour of fluids at rest and in motion.
- Teach the mathematical description of fluid flow, including conservation laws.
- Explore different types of fluid flows and their applications.
- Enable students to analyse and solve problems related to fluid mechanics.
- Focus on practical applications in engineering and science.

Course Outcome

- Understanding of the fundamental concepts and principles of fluid mechanics.
- Proficiency in analysing fluid flow, pressure, and velocity distributions.
- Capability to solve problems related to static and dynamic fluid behaviours.
- Ability to analyse and discuss different types of fluid flows and their applications.
- Skills to apply theoretical concepts to practical engineering problems.

Unit I: **Basic Concepts of Fluid Properties** **9**

Pressure head – measurement of pressure – static force – hydrostatic force on plane and curved surfaces – buoyancy – metacenter – metacentric height – stability of submerged and floating bodies.

Unit II: **Velocity** **9**

Rate of flow – acceleration – continuity equation – rotation and vorticity – velocity potential and stream function – flow net – Bernoullie's equation – application of Bernoullie's equation – cavitation – one-dimensional unsteady flow.

Unit III: **Navier Stoke's Equation** **9**

Introduction to mass, momentum and energy transfer – momentum equation – Navier Stoke's equation – impulse-momentum equation and its applications – dimensions and equations – Buckingham π theorem– dimensionless numbers and its significance – models – laws of similitude.

Unit IV: **Concept of Boundary Layer** **9**

Concept of boundary layer – boundary layer growth over a flat plate- boundary layer thickness, displacement, momentum and energy thickness – Solution of simplified Navier Stokes equation: Blasius solution – laminar and turbulent boundary layers – drag force in laminar and turbulent flow – boundary layer separation and control.

Unit V: **Reynold's Experiment** **9**

Hagen Poiseuille equation – Stoke's Law – Measurement of viscosity – Darcy Weisbach equation – Friction factor – losses due to sudden enlargement, contraction, bends and elbows – compound pipes – flow measurement.

TEXTBOOK

1. R. A. Granger, *Fluid Mechanics*. New York, NY, USA: CBS College Publishing, 1995.
2. R. Fox and Mc Donald, *Introduction to Fluid Mechanics*. 8th ed., New York, NY, USA: John Wiley & Sons Inc., 2010.
3. F. M. White, *Fluid Mechanics*. 9th ed., McGraw Hill, 2022.
4. B. R. Munson, D. F. Young, T. H. Okiishi, and W. W. Huebsch, *Fundamentals of Fluid Mechanics*. 7th ed., Wiley, 2017.
5. Y. A. Çengel and J. M. Cimbala, *Fluid Mechanics: Fundamentals and Applications*. 4th ed., McGraw Hill, 2017.

REFERENCE BOOKS

1. J. A. Roberson and C. T. Crowe, *Engineering Fluid Mechanics*. Mumbai, India: Jaico Publishing House, 1999.
2. S. W. Yuan, *Foundation of Fluid Mechanics*. New Delhi, India: Prentice Hall of India, 1988.
3. P. N. Modi and Seth, *Hydraulics and Fluid Mechanics*. New Delhi, India: Standard Book House, 1998.
4. G. K. Batchelor, *An Introduction to Fluid Dynamics*. 2nd ed. Cambridge University Press, 2000.
5. B. S. Massey and H. A. Wadee, *Hydrodynamics Around Cylindrical Structures*. Revised ed., World Scientific Publishing Co Pte Ltd, 2006.
6. S. B. Pope, *Turbulent Flows*. Cambridge University Press, 2009.

Online Study Material

Websites:

- MIT OpenCourseWare: Fluid Mechanics and its Applications
- Khan Academy: Fluid Dynamics and Viscosity
- LearnChemE - Fluid Mechanics Module
- Coursera: Fluid Mechanics Courses

Video Resources:

- YouTube channels like "Learn Engineering," "NPTEL - Mechanical Engineering," and "The Engineering Mindset"
- Platforms like Coursera, Udemy, and edX offer courses on fluid mechanics.

Additional Resources:

- Access to research papers and case studies in the field of fluid mechanics.
- Utilize software for simulation and visualization of fluid flow.

FLUID MECHANICS LAB

Objectives

- To have knowledge on flow measurements using various devices.
- To give hands-on experience on the flow through different types of notches.
- To gain experimental knowledge on the computation of major losses in pipes.
- To train students on the determination of minor losses in pipes.
- To study the characteristics of various pumps and wind tunnel.

Outcomes

- The students will be able to measure flow through pipes.
- The students will be able to measure flow in open channel.
- The students will be able to compute the major and minor losses in pipes.
- The students will be able to study the characteristics of pumps.
- The students will be able to analyse the performance of pumps.

List Of Experiments

1. FLOW MEASUREMENT

- Calibration of Rotameter
- Flow through Venturimeter
- Flow through a circular Orifice
- Determination of mean velocity by Pitot tube
- Flow through a Triangular Notch
- Flow through a Rectangular Notch

2. LOSSES IN PIPES

- Determination of friction coefficient in pipes
- Determination of losses due to bends, fittings and elbows

3. PUMPS

- Characteristics of Centrifugal pump
- Characteristics of Submersible pump
- Characteristics of Reciprocating pump

4. Wind Tunnel

- Velocity and Total Pressure Measurement using Pitot tube.
- Static Pressure Measurement using Projection Manometer.
- Estimation of Pressure distribution of symmetric airfoil.
- Estimation of Pressure distribution of Cambered airfoil.
- Estimation of Pressure distribution on cylinder.

- Estimation of Pressure distribution on sphere.
- Flow Visualization on airfoil, cylinder and sphere.

REFERENCE BOOKS

1. "*Hydraulic Laboratory Manual*", Centre for Water Resources, Anna University, 2004.
2. Modi P.N. and Seth S.M., "*Hydraulics and Fluid Mechanics*", Standard Book House, New Delhi, 2000.
3. Subramanya, K., "*Flow in Open Channels*", Tata McGraw - Hill Pub. Co.1992.
4. Subramanya, K., "*Fluid Mechanics*", Tata McGraw- Hill Pub. Co., New Delhi, 1992.

AVAS242 (AV4MJ7): FUNDAMENTALS OF APPLIED THERMODYNAMICS

L	T	P	C	45L
3	2	0	4	

Prerequisites

- Fundamental knowledge of physics and chemistry.
- Familiarity with basic concepts of thermodynamics and energy.
- Understanding of mathematical concepts related to heat transfer and energy conversion.

Course Objective

- Introduce the basic laws and principles of thermodynamics.
- Teach the concepts of heat, work, energy, and their conversions.
- Explore different thermodynamic processes and cycles.
- Enable students to analyse and solve problems related to basic thermodynamic systems.
- Focus on practical applications in engineering and energy-related fields.

Course Outcome

- Understanding of the fundamental laws of thermodynamics, including the first and second laws.
- Proficiency in analysing energy transfers, heat engines, and refrigeration systems.
- Capability to solve problems related to basic thermodynamic processes and cycles.
- Ability to analyse and discuss different applications and efficiencies in thermodynamic systems.
- Skills to apply theoretical concepts to practical engineering problems.

Unit I: **Real Gas Equation and Pure Substances** **9**

Law of perfect gases – Boyles law – Charles law – Gay Lussac law – Joules law – Avogadro's law – characteristic equation of gases – specific heat of gases – Regnaults law – Perfect gases – Vander Walls equation – Redlich Kwong equation – Dietric equation – properties of pure substances – pure substance – phase change – thermodynamic diagram of a simple compressible substances – thermodynamic substances – properties of steam – tables of thermodynamic properties – Mollier diagram – gaseous phase.

Unit II: **Thermodynamic Analysis of System** **9**

Energy and first law of thermodynamics – thermodynamic concept of energy – energy transfer – energy accounting – energy balance for closed and open system. Exergy analysis – introduction to exergy – closed system exergy balance – flow exergy – exergy rate balance for control volume – second law efficiencies.

Unit III: **Conservation of Energy and Mass** **9**

General Conservation of Energy and mass principles for control volume – Charging and discharging Rigid Vessels – Transient System analysis with boundary work – Irreversibility and Availability in Transient Systems.

Unit IV: **Thermodynamic Properties** **9**

General thermodynamic properties and its relation – Helm Holtz and Gibbs function – Gibbs phase equilibrium condition – Maxwell equation – Clapeyran equation – Newton Raphson technique – property relation.

Unit V: Combustion Reactions **9**

Enthalpy of formation – Steady flow analysis of reacting mixtures – Adiabatic combustion temperature – Enthalpy of reaction and heating values – Second law analysis of chemical reactions – Availability analysis of chemical reactions.

TEXTBOOK

1. K. Nag, *Engineering Thermodynamics*. New Delhi, India: Tata McGraw Hill Publishing Co. Ltd., 2003.
2. M. J. Moran and H. N. Shapiro, *Fundamentals of Engineering Thermodynamics*. Singapore: John Wiley & Sons, 2000.
3. E. Rathakrishnan, *Fundamentals of Engineering Thermodynamics*, 2nd ed. New Delhi, India: PHI Learning Pvt. Ltd., 2008.
4. Y. A. Çengel and M. A. Boles, *Thermodynamics: An Engineering Approach*. 9th ed., McGraw Hill, 2019.

REFERENCE BOOKS

1. C. P. Arora, *Thermodynamics*. New Delhi, India: Tata McGraw Hill Publishing Co. Ltd., 1998.
2. K. Wark, *Thermodynamics*. New York, NY, USA: McGraw Hill Book Publishing Co., 1985.
3. J. P. O'Connell, *Thermodynamics: Fundamentals for Applications*. Reissue ed., Cambridge University Press, 2011.
4. I. Granet, *Thermodynamics and Heat Power*. 4th ed., Prentice Hall, 1990.
5. J. M. Honig, *Thermodynamics: Principles Characterizing Physical and Chemical Processes*. 4th ed., Academic Press Inc, 2013.

Online Study Material

Websites:

- MIT OpenCourseWare: Thermodynamics courses
- Khan Academy: Thermodynamics and Energy
- LearnThermo - Basic Thermodynamics Module
- Coursera: Thermodynamics Courses

Video Resources:

- YouTube channels like "LearnChemE," "NPTEL - Mechanical Engineering," and "The Organic Chemistry Tutor"
- Online platforms like Coursera, Udemy, and edX offer courses on thermodynamics.

Additional Resources:

- Access to research papers and case studies in the field of thermodynamics.
- Utilize software for simulation and visualization of thermodynamic processes.

AVAS243 (AV4MJ8): SIGNALS AND SYSTEMS FOR AVS

L	T	P	C	45L
3	2	0	4	

Prerequisites

- Basic knowledge of mathematics, including calculus and linear algebra.
- Understanding of basic circuit theory and electronics.
- Familiarity with fundamental concepts of physics and engineering.

Course Objective

- Introduce fundamental concepts of signals and systems.
- Teach mathematical representation and analysis of continuous and discrete signals.
- Explore linear time-invariant systems and their properties.
- Enable students to understand the concepts of convolution and Fourier analysis.
- Focus on practical applications in various engineering domains.

Course Outcome

- Understanding of basic signal properties, including amplitude, frequency, and phase.
- Proficiency in mathematical representation and analysis of continuous and discrete signals.
- Capability to analyse linear time-invariant systems and their response to different inputs.
- Ability to apply convolution and Fourier analysis to analyse and design systems.
- Skills to apply theoretical concepts to real-world signal processing problems.

Unit I: **Representation of Signals and Systems** 9

Continuous-time signals –Discrete-time signals – Representation of signals – Step, Ramp, Pulse, Impulse, Sinusoidal, Exponential signals, Operation on the signals – Classification of continuous time and discrete time signals – Periodic, Aperiodic, Deterministic, Random, Even, Odd, Energy and Power Signals – Continuous time and discrete time systems – Classification of systems – Properties of systems.

Unit II: **Continuous Time Signal Representation / Analysis** 9

Fourier series analysis – Representation of periodic signals in trigonometric and exponential forms – Fourier transform analysis of aperiodic signals – Spectral analysis of periodic and aperiodic signals– Parseval's theorem for periodic and aperiodic signals – Laplace transform in signal analysis.

Unit III: **Continuous Time Systems** 9

LTI continuous time systems – Differential equation – Block diagram representation and reduction techniques – impulse response – Convolution integral – Properties of LTI continuous time systems – Frequency response of continuous-time LTI systems – Analysis of LTI systems using Fourier and Laplace transform techniques – State variable representation of LTI systems.

Unit IV: **Discrete Time Signal Representation / Analysis** 9

Discrete-time Fourier series – Discrete-time Fourier transform – Spectrum of discrete-time periodic and aperiodic signals – Parseval relations – Z transform – Properties and application to discrete-time signal analysis – Inverse Z transform.

Unit V: **Discrete Time Systems** 9

LTI discrete-time systems – Difference equation – Block diagram representation and reduction techniques – impulse response – Convolution Sum – Properties of discrete-time LTI systems – Frequency response – Analysis of LTI systems using Fourier and Z transform techniques – State variable representation of discrete-time LTI systems.

TEXTBOOK

1. S. Haykins and B. Van Veen, *Signals and Systems*, 2nd ed. Hoboken, NJ, USA: John Wiley & Sons, 2002.
2. A. V. Oppenheim, A. S. Willsky, and S. H. Nawab, *Signals and Systems*. ; 2nd ed., PHI, 1996.
3. R. E. Ziemer, W. H. Tranter, and D. R. Fannin, *Signals and Systems: Continuous and Discrete*. 4th ed., Pearson, 1998.
4. A. Anand Kumar, *Signals and Systems*. 3rd ed., Prentice Hall India Learning Private Limited, 2013.
5. M. N. O. Sadiku, *Signals and Systems: A Primer with MATLAB*. 1st ed., CRC Press, 2015.

REFERENCE BOOKS

1. A. V. Oppenheim, A. S. Willsky, and S. H. Nawab, *Signals and Systems*, 2nd ed. New Delhi, India: PHI Learning, 2007.
2. D. K. Lindner, *Signals and Systems*. New York, NY, USA: McGraw-Hill International Edition, 1999.
3. S. Haykin and B. Van Veen, *Signals and Systems*. 2nd ed., Wiley, 2007.
4. M. J. Roberts, *Signals and Systems: Analysis Using Transform Methods & MATLAB*. 2nd ed., McGraw-Hill Education, 2011.
5. J. G. Proakis and D. G. Manolakis, *Digital Signal Processing: Principles, Algorithms, and Applications*. 4th ed., Pearson Education India, 2007.
6. S. S. Soliman and M. D. Srinath, *Continuous and Discrete Signals and Systems*. 2nd ed., Pearson, 1998.

Online Study Material

Websites:

- Khan Academy: Signals and Systems
- MIT OpenCourseWare: Signals and Systems
- NPTEL: Signals and Systems
- Coursera: Signal Processing Courses

Video Resources:

- YouTube channels like "MathTheBeautiful," "MIT OpenCourseWare," and "The Signal Path"
- Online platforms like Coursera, Udacity, and edX offer courses on signals and systems.

Practical Platforms:

- MATLAB or Octave for signal processing simulations.
- Online tools for visualizing signals and systems.

AVAS244 (AV4MI10): WORKSHOP TECHNOLOGY

L	T	P	C	45L
3	0	2	4	

Prerequisites: NIL

Course Objective

- To provide students with theoretical knowledge and practical skills in various workshop processes and operations.
- To familiarize students with the tools, equipment, and techniques used in workshop environments and to develop their abilities to perform basic workshop tasks safely and efficiently.

Course Outcome

- Understanding of Workshop Safety Practices
- Proficiency in Hand Tool Operations
- Competence in Power Tool Operations
- Knowledge of Workshop Machinery
- Skill in Workshop Processes

Unit I: **Materials** **9**

Composition, physical and mechanical properties. Engineering uses of common metals and their alloys such as cast iron and varieties of cast iron, wrought iron, mild steel, medium carbon steel. Tool steels, highspeed steels. Effect of alloying elements. Alloys of aluminium, tin, copper, zinc and magnesium, bearing materials.

Unit II: **Heat Treatment of Steels** **9**

Relation between heat treatment and physical properties of steels, critical temperatures, annealing, normalizing hardening, tempering, case carburising and hardening, nitriding and other surface hardening methods, quenching, Hardness number. Hardness Testing Machines.

Unit III: **Fitting Work** **9**

Files, their specifications and uses, marking scheme for a fitting job, surface plates, vee blocks, marking block, steel scale, punch, vernier caliper, micrometre, hammers, scrapers, chisels, angle plates, bench vice, spanners - their specifications and uses, Pipe and chain wrenches, hacksaws. Drilling, lapping and die cutting.

Unit IV: **Sheet Metal Working** **9**

Shearing, bending, cup drawing, operations, presses and press working operations, classification of presses, press tools.

Shaping Machines: Principles of operation - types of driving mechanisms, feed and speed control, hydraulic shapers.

Slotting Machines: Principle of operation - driving mechanisms, feed control

Planing Machines: Methods of driving planners - clamping of work, cutting speeds, etc.
Drilling Machines: Vertical, radial, speed and feed control mechanism

Unit V: **Lathes** **9**

Types of Lathes: Description of lathe, headstock, tailstock, gear box, carriage, apron, feed controls - longitudinal and transverse, compound tool resets, cutting speeds and feeds, leadscrew, change gears, Lathe accessories, Lathe Operations: surfacing, sliding and screw cutting, taper turning.
Chucks: 3-jaw, 2-jaw, use of soft jaws, faceplate - carriers
Milling Machine: Plane milling machine, universal milling machines, universal dividing head, rotory table, cutting tools used in milling.
Numerical Control Manufacturing: Nomenclature of NC Machines, Axis, types of NC Machines, Features of NC Machine Tools, Machine Control Unit, Computer programme for computer aided part programming.

Workshop Technology Lab **30**

1. Fitting shop: Use of drilling m/c. Files. Hacksaw.
2. Welding shop: Gas Welding & Electric Arc Welding, Spot Welding, Joints.
3. Carpentry shop: Planer, Marking tools, Joints, Pattern making.
4. Sheet Metal shop: Development of surfaces, Joints, Soldiering, Brazing.
5. Machine shop: Introduction to lathe, Milling m/c. shapers, if possible, NC and CNC m/cs.
6. Foundry shop: sand, Binders, Moulding Boxes, Moulds, Casting.
7. Forging shop: Anvil. Swage block, tools. Forging Manual. Steam Hammers.

TEXTBOOK

1. W. A. J. Chapman, *Workshop Technology*, Parts I, II & III. 5th ed., CBS Publication, 2001.
2. S. K. Hajra Choudhury and S. C. Bhattacharya, *Elements of Workshop Technology*, Vol. I & II. Media Promoters & Publishers, 2008.
3. T. K. Kundra, P. N. Rao, and N. K. Tiwari, *Numerical Control and Computer Aided Manufacturing*. Tata Mcgraw Hill, 1987.

REFERENCE BOOKS

1. V. Austin, *Workshop Theory*. 3rd ed., London, UK: Macmillan and Co. Ltd. 1975.
2. F. H. Hallet, *Machine Shop Theory and Practice*. ; Revised ed., London, UK: Macmillan & Co. Ltd., 1969.
3. C. H. Sumans, *Engineering Metals and Their Alloys*. 1st ed., London, UK: Macmillan & Co. Ltd., 1949.

AVAS244 (AV4MI11): PRINCIPLES OF CYBER SECURITY

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic understanding of computer systems and networks.
- Familiarity with fundamental concepts of information technology.
- Knowledge of programming basics is beneficial but not mandatory.

Course Objective

- Introduce fundamental principles and concepts of cyber security.
- Teach the importance of confidentiality, integrity, and availability in information security.
- Explore common cyber threats and attack vectors.
- Enable students to implement security measures to protect against cyber threats.
- Foster an understanding of ethical and legal considerations in cyber security.

Course Outcome

- Understanding of the principles and goals of cyber security.
- Proficiency in identifying and analysing common cyber threats.
- Capability to implement security measures to protect information systems.
- Ability to assess and mitigate vulnerabilities in computer systems.
- Awareness of ethical and legal aspects related to cyber security.

Unit I: Introduction To Security Trends **9**

The Computer Security Problem - Targets and Attacks - Approaches to Computer Security - Ethics - Basic Security Terminology - Security Models.

Unit II: Operational and Organizational Security **9**

Policies, Procedures, Standards, and Guidelines - Security Awareness and Training – Interoperability Agreements - The Security Perimeter - Physical Security - Environmental Issues - Wireless - Electromagnetic Eavesdropping – People-A Security Problem - People as a Security Tool.

Unit III: Cryptography **9**

Cryptography in Practice - Historical Perspectives - Algorithms - Hashing Functions – Symmetric Encryption - Asymmetric Encryption - Quantum Cryptography- Cryptography Algorithm Use.

Unit IV: Authentication and Remote Access **9**

User, Group, and Role Management - Password Policies - Single Sign-On - Security Controls and Permissions - Preventing Data Loss or Theft - The Remote Access Process - Remote Access Methods.

Unit V: Intrusion Detection Systems **9**

History of Intrusion Detection Systems - IDS Overview - Network-Based IDSs - Host-Based IDSs Intrusion Prevention Systems - Honeypots and Honeynets – Tools.

TEXTBOOK

1. W. A. Coklin and G. White, *Principles of Computer Security.* 4th ed., New York, NY, USA: McGrawHill, 2016.
2. W. Stallings, *Cryptography and Network Security Principles and Practices*, 7th ed. Boston, MA, USA: Pearson, 2017.
3. T. J. Smedinghoff, R. L. Trope, and A. J. Diana, *Cybersecurity: A Practical Guide to the Law of Cyber Risk*. 1st ed., Practising Law Inst.,2015.
4. W. Stallings and L. Brown, *Computer Security: Principles and Practice*. 4th ed., Pearson, 2017.
5. Harvard Business Review, *Cybersecurity: The Insights You Need from Harvard Business Review*, 2019.

REFERENCE BOOKS

1. A. S. Godbole, *Web Technologies: TCP/IP, Web/Java Programming, and Cloud Computing*. New Delhi, India: Tata McGraw-Hill Education, 2013.
2. W. Stallings, *Network Security Essentials*. 6th ed., Pearson Education, 2018.
3. S. Harris, *CISSP All-in-One Exam Guide*.8th ed., McGraw Hill, 2018.
4. R. J. Anderson, *Security Engineering: A Guide to Building Dependable Distributed Systems*. 2nd ed., John Wiley & Sons, 2008.
5. M. Zalewski, *The Tangled Web: A Guide to Securing Modern Web Applications*. 1st ed., No Starch Press, US, 2011.
6. N. Dhanjani, B. Rios, and B. Hardin, *Hacking: The Next Generation*. 1st ed., O′Reilly, 2009.

Online Study Material

Websites:

- Cybrary: Online Cyber Security Courses
- OWASP (Open Web Application Security Project): Web Application Security Guide
- Coursera: Cyber Security Courses

Video Resources:

- YouTube channels like "HackerSploit," "The Cyber Mentor," and "LiveOverflow"
- Online platforms like Udemy, Coursera, and edX offer courses on cyber security.

Practical Platforms:

- TryHackMe and Hack The Box for hands-on cyber security challenges.
- Virtualization tools like VirtualBox or VMware for setting up virtual environments.

AVAS244 (AV4MI12): DATA WAREHOUSING

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic understanding of databases and database management systems.
- Familiarity with SQL and relational database concepts.
- Knowledge of business processes and information systems.
- Understanding of data modelling and design.

Course Objective

- Introduce the fundamental concepts of data warehousing.
- Teach the design and architecture of data warehouses.
- Explore ETL (Extract, Transform, Load) processes for data integration.
- Enable students to understand the importance of data quality and governance.
- Focus on practical applications of data warehousing in business intelligence.

Course Outcome

- Understanding of the principles and architecture of data warehousing.
- Proficiency in designing and implementing data warehouses.
- Capability to perform ETL processes for integrating data into a data warehouse.
- Ability to ensure data quality and governance in a data warehousing environment.
- Skills to apply data warehousing concepts in business intelligence and analytics.

Unit I: **Introduction** **9**

Data warehouse delivery method – system process – typical process flow within a data warehouse – query management process – process architecture – meta data-data mart.

Unit II: **Design Aspects** **9**

Designing dimension tables – Designing star flake schema – Multi dimensional schema – partitioning strategy aggregations – Data mart- Metadata – System Data warehouse process manager.

Unit III: **Hardware and Operational Design** **9**

Server hardware, network hardware – parallel technology – Security input on the design of Hardware – backup and recovery – Service level Agreement – Operating the data warehouse.

Unit IV: **Planning and Development** **9**

Capacity planning – Estimating the load – Tuning the data warehouse – Assessing performance –Tuning the data load and queries – Testing data warehouse – Development of test plan – Testing the data base and operational environment.

Unit V: **Case Studies** **9**

Data Warehousing in the Tamil Nadu Government - Data Warehouse for the Ministry of commerce- Data Warehouse for the Government of Andhra Pradesh- Data Warehousing in Hewlett –Packard- Data Warehousing in Levi Strauss Data Warehousing in the World Bank- HARBOR, A Highly available Data Warehouse-A typical Business data Warehouse for a Trading company.

TEXTBOOK

1. S. Anahory and D. Murray, *Data Warehousing in the Real World*. 1st ed., Boston, MA, USA: Pearson Education, 2002.
2. P. C. S. R. Prabhu, *Data Warehousing: Concepts, Techniques, Products and Applications*, 3rd ed. New Delhi, India: PHI Learning, 2009.
3. R. Kimball and M. Ross, *The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling*. 3rd ed., John Wiley & Sons, 2013.
4. W. H. Inmon, *Building the Data Warehouse*. 4th ed., Wiley, 2005.
5. M. Golfarelli, S. Rizzi, and A. Saccà, *Data Warehouse Design: Modern Principles and Methodologies*. McGraw-Hill, 2009.

REFERENCE BOOKS

1. A. Vaisman and E. Zimányi, *Data Warehouse Systems: Design and Implementation*. 1st ed., Springer-Verlag Berlin, 2014.
2. C. S. R. Prabhu, *Data Warehousing: Concepts, Techniques, Products, and Applications*. 3rd ed., PHI, 2010.
3. M. Godinez, E. Hechler, K. Koenig, and S. Lockwood, *The Art of Enterprise Information Architecture: A Systems-Based Approach for Unlocking Business Insight*. 1st ed. Pearson, 2010.
4. P. Ponniah, *Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals*. 2nd ed., John Wiley & Sons Inc., 2010.
5. C. Imhoff, N. Galemmo, and J. G. Geiger, *Mastering Data Warehouse Design: Relational and Dimensional Techniques*. 1st ed., John Wiley & Sons Inc., 2003.

Online Study Material

Websites:

- Oracle Learning Library: Data Warehousing Tutorials
- Microsoft Docs: SQL Server Data Warehouse Concepts
- IBM Knowledge Center: Data Warehousing
- Coursera: Data Warehousing Courses

Video Resources:

- YouTube channels like "edureka!" and "TechWithTim"

- Online platforms like Coursera, Udacity, and edX offer courses on data warehousing.

Additional Resources:

- Access to industry reports and case studies on successful data warehousing implementations.
- Use of data warehousing tools and platforms for hands-on experience.

FIFTH SEMESTER

AVAS351 (AV5MJ9): ROBOTICS AND SYSTEM AUTOMATION

L	T	P	C	45L
3	0	2	4	

Prerequisites: NIL

Course Prerequisites

- Basic understanding of mathematics and physics.
- Familiarity with elementary programming concepts.
- Knowledge of mechanical systems and engineering principles.

Course Objective

- Introduce the fundamental concepts of robotics and automation.
- Teach the principles of robot design, kinematics, and dynamics.
- Explore automation technologies and their applications in industry.
- Enable students to understand the role of sensors and actuators in robotics.
- Focus on practical applications of robotics and automation in various fields.

Unit I: Fundamentals of Robot **9**

Robot - Definition - Robot Anatomy - Coordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, PayLoad-Robot Parts and their Functions-Need for Robots-Different Applications.

Unit II: Robot Drive Systems and End Effectors **9**

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

Unit III: Sensors and Machine Vision **9**

Requirements of a sensor, Principles and Applications of the following types of sensors-Position sensors - Piezo-Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors, binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data- Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications- Inspection, Identification, Visual Serving and Navigation.

Unit IV: Robot Kinematics and Robot Programming **9**

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems. Lead

through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple Programs.

Unit V: Implementation And Robot Economics **9**

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

TEXTBOOK

1. R.D. Klafter, T.A Chmielewski and M. Negin, *Robotic Engineering - An Integrated Approach*, Prentice Hall, 2003.
2. M.P. Groover, *Industrial Robotics -Technology Programming and Applications*, McGraw Hill, 2001.
3. J. J. Craig, *Introduction to Robotics: Mechanics and Control*. 4th ed., Harlow, United Kingdom: Pearson Education Limited, 2022.
4. B. Siciliano and L. Sciavicco, *Robotics: Modelling, Planning and Control*. 2nd ed., London: Springer London, 2000.
5. A.K. Gupta, *Industrial Automation and Robotics*. Stylus Publishing, 2023.

REFERENCE BOOKS

1. Craig J. J., *Introduction to Robotics Mechanics and Control*, 3rd ed., Pearson Education, 2008.
2. Deb S.R., *Robotics Technology and Flexible Automation*. 2nd ed., Tata McGraw Hill Book Co., 2017.
3. Koren Y., *Robotics for Engineers*, Mc Graw Hill Book Co., 1992.
4. Fu. K. S., Gonzalz R.C. and Lee C.S.G., *Robotics Control, Sensing, Vision and Intelligence*, McGraw Hill Book Co., 1987.
5. Janakiraman P.A., *Robotics and Image Processing*, Tata McGraw Hill, 1995.
6. Rajput R.K., *Robotics and Industrial Automation*, S. Chand and Company, 2008.

Online Study Material

Websites:

- Robot Academy: Robotics Courses by Carnegie Mellon University
- ROS (Robot Operating System) Documentation
- edX: Robotics Courses
- Coursera: Automation and Robotics Courses

Video Resources:

- YouTube channels like "Boston Dynamics" and "Robotics with ROS"
- Online platforms like Coursera, Udacity, and edX offer courses on robotics and automation.

Additional Resources:

- Access to robotic simulation tools for hands-on experience.
- Participation in robotics competitions and workshops.
- Exploration of research papers and journals in the field of robotics.

AVAS352 (AV5MJ10): COMPUTER-AIDED DESIGN

L	T	P	C	45L
3	0	2	4	

Prerequisites: NIL

Course Objective

- The primary objective of a course in Computer-Aided Machine Drawing is to equip students with the knowledge and skills necessary to create detailed engineering drawings using computer-aided design (CAD) software.
- The course aims to familiarize students with drawing conventions, standards, and techniques, as well as to develop their proficiency in interpreting and generating technical drawings for machined components and assemblies.

Course Outcome

After learning the course, the students should be able to:

- Understand and appreciate use of computer in product development.
- Apply algorithms of graphical entity generation.
- Understand mathematical aspects of geometrical modelling.
- Understand and use finite element methods for analysis of simple components.

Unit I: Introduction **9**

A typical product cycle, CAD tools for the design process of product cycle, CAD / CAM system evaluation criteria, Input / Output devices; Graphics Displays: Refresh display, DVST, Raster display, pixel value and lookup table, estimation of graphical memory, LCD, LED fundamentals. Concept of Coordinate Systems: Working Coordinate System, Model Coordinate System, Screen Coordinate System. Line and Curve generation algorithm: DDA, Bresenham's algorithms. Graphics exchange standards and Database managements.

Unit II: Curves and Surfaces **9**

Parametric representation of lines: Locating a point on a line, parallel lines, perpendicular lines, distance of a point, Intersection of lines. Parametric representation of circle, Ellipse, parabola and hyperbola. Synthetic Curves: Concept of continuity, Cubic Spline: equation, properties and blending. Bezier Curve: equations, properties.

Mathematical representation of solids: Geometry and Topology, Comparison of wireframe, surface and solid models, Properties of solid model, properties of representation schemes, Concept of Half-spaces, Boolean operations. Schemes: B-rep, CSG, Sweep representation, ASM, Primitive instancing, Cell Decomposition and Octree encoding.

Unit IV: Geometric Transformations **9**

Homogeneous representation; Translation, Scaling, Reflection, Rotation, Shearing in 2D and 3D; Orthographic and perspective projections. Window to View-port transformation.

Unit V: Finite Element Analysis **9**

Review of stress-strain relation and generalized Hooke's Law, Plane stress and Plane strain conditions; Concept of Total Potential Energy; Basic procedure for solving a problem using Finite Element Analysis. 1-D Analysis: Concept of Shape function and natural coordinates,

strain-displacement matrix, derivation of stiffness matrix for structural problems, properties of stiffness matrix. 1-D structural problems with elimination and penalty approaches, 1-D thermal and fluid problems. Trusses and Beams: Formulation of stiffness matrix, simple truss problems to find displacement, reaction and stresses in truss members. Structural analysis using Euler-Bernoulli beam element. Higher Order Element: CST element stiffness matrix formulation, shape functions and applications of Quad and axisymmetric elements.

TEXTBOOK

1. F. E. Giesecke, I. L. Hill, A. Mitchell, *Technical Drawing with Engineering Graphics*, 17th ed., Pearson, 2017.
2. C. R. Alavala, *CAD/CAM: Concepts and Applications*, CRC Press, 2008.
3. J. D. Bethune, *Engineering Graphics with AutoCAD*. 1st ed., Peachpit Press, 2016.
4. K. Plantenberg, *Introduction to CATIA V5 Release 19*. 1st ed., SDC Publications, 2009.

REFERENCE BOOKS

1. N. D. Junnarkar "*Machine Drawing*". 1st ed., Pearson, 2004.
2. D. A. Madsen, *Engineering Drawing and Design*. 6th ed., Cengage Learning, 2016.
3. J. D. Meadows, *Geometric Dimensioning and Tolerancing: Applications, Analysis & Measurement*. 2nd ed., Wiley, 2010.
4. "*SolidWorks 2021 Learn by Doing*". Tutorial Books, 2021.
5. "AutoCAD 2021 For Beginners". CADFolks, 2021.

Online Study Material

1. **YouTube Channels**:
   - Tutorials and demonstrations on CAD software and machine drawing techniques from channels such as AutoCAD, SolidWorks, and CATIA.
2. **Coursera**:
   - Courses on engineering drawing, CAD fundamentals, and 3D modeling offered by universities and training providers.
3. **Udemy**:
   - Online courses on machine drawing, technical drawing, and CAD software tools for beginners and advanced users.
4. **Khan Academy**:
   - Interactive tutorials and exercises on geometry, trigonometry, and engineering drawing concepts.
5. **MIT OpenCourseWare**:
   - Lecture notes, assignments, and resources from MIT courses on mechanical engineering and CAD/CAM technologies.

COMPUTER-AIDED DESIGN LAB

List of Exercises **30**

Using the Auto CAD Script file, draw the orthographic views for the given simple 3D blocks
Preparation of Drawings for Parts and Assembly of the following by using AutoCAD.

1. Joints: Riveted Joints - Butt & Lap joints, Knuckle joint,
2. Couplings: flexible type flange coupling, Universal coupling.
3. Bearing: Pedestal bearing.
4. Screw jack.
5. Connecting rod.
6. Tail stock.
7. Steam Stop valve.
8. Rams bottom Safety Valve.

AVAS353 (AV5MJ11): ANALOG AND DIGITAL COMMUNICATION SYSTEMS FOR AUTOMATION

L	T	P	C	45L
3	1	0	4	

Prerequisites

- Basic understanding of electrical circuits and signals.
- Familiarity with mathematical concepts such as calculus and complex numbers.
- Knowledge of basic electronics and circuit analysis.
- Understanding of introductory communication theory is beneficial but not mandatory.

Course Objective

- Introduce the fundamental concepts of analog and digital communication.
- Teach the principles of signal modulation and demodulation.
- Explore analog communication techniques, including amplitude and frequency modulation.
- Introduce the basics of digital communication, including pulse modulation and digital modulation.
- Focus on practical applications and real-world examples in communication systems.

Course Outcome

- Understanding of the basic principles and history of analog and digital communication.
- Proficiency in analysing and designing analog and digital communication systems.
- Capability to perform modulation and demodulation processes.
- Ability to apply theoretical concepts to practical communication problems.
- Skills to analyse and optimize communication system performance.

Unit I: Noise and Amplitude Modulation **9**

General communication systems-external and internal noise-Noise figure and noise temperature-AWGN-Need for modulation-Amplitude modulation- Frequency spectrum-Power relation-Different types of AM modulators-SSB and VSB generation-AM transmitters-Block diagram-Functions of each block-High level transmitter. Angle Modulation: Principle of frequency and phase modulation-Relation between FM and PM waves-Bandwidth of FM-Narrow band and wideband FM-Generation of FM wave Direct and Indirect methods transmitters-Block diagram-Function of each block.

Unit II: Detection and Receivers **9**

Detection-Diode, Detectors-Synchronous, detection-FM, detectors-Slope, Detectors-Phase, Discriminators-Ratio detectors, Receivers- different types super heterodyne receivers- Block diagram-choice of IF and oscillator frequencies Tracking-Alignment-AVC, AFC-Communication receivers- AM and FM – Receiver characteristics. Pulse Modulation Systems and RADAR: Sampling Theorem-Generation and detection of PAM, PWM and PPM-Conversion of PWM to PPM- TDM and FDM. Basic principles of RADAR system- Range equation- Pulse radar system- MIT radar- CW Radar- FM CW Radar.

Unit III: Base Band Transmission **9**

Base Band Transmission - Waveform representation of binary digits - PCM, DPCM, DM, ADM systems - Detection of signals in Gaussian noise - Matched filter - Application of matched filter - Error probability performance of binary signaling - Multilevel baseband transmission - Inter symbol interference - Eye pattern - Companding - A law and μ law-correlation receiver.

Unit IV: Band Pass Transmission **9**

ASK, FSK, PSK, QPSK, DQPSK, MSK, QAM - Detection of signals in noise - Coherent and Non-coherent detection of ASK, FSK and PSK - Comparison of error performance of non-coherently and coherently detected ASK, FSK and PSK systems - M-ary signaling - Vectorial view of MPSK and MFSK – error performance Spread Spectrum.

Unit V: Communication **9**

Spread spectrum technologies - spreading techniques - PN sequences - Direct sequence spread spectrum systems - Frequency hopping spread spectrum systems - Hybrid systems - Demodulation schemes - RAKE Receivers - Use of spread spectrum with code division multiple access. Synchronization: Receiver synchronization - Coherent systems - Symbol and frame synchronization - Network synchronization - Open and closed loop transmitter synchronization - Tracking and acquisition in spread spectrum system.

TEXTBOOK

1. G. Kennedy and B. Davis, *Electronic Communication Systems*, 4th ed., Tata McGraw Hill, 2008.
2. B. Sklar, *Digital Communication*, 2nd ed., Edition, Prentice Hall, Upper Saddle River, NJ, 2008.
3. S. Haykin, *Digital Communications*, John Wiley and Sons, 2008.
4. S. Haykin, Communication Systems. 4th ed., Wiley, 2006.
5. H. Taub, D. L. Schilling, G. Saha, *Principles of Communication Systems*. 4th ed., McGraw Hill Education, 2017.
6. B.P. Lathi, *Modern Digital and Analog Communication Systems*. 4th ed., Oxford, 2011.
7. J. G. Proakis, M. Salehi, *Communication System Engineering*. 2nd ed., Pearson, 2018.
8. K. S. Shanmugam, Analog and Digital Communication. Wiley India Pvt Ltd., 2006.

REFERENCE BOOKS

1. Roddy and Coolen, *Communication Systems*, PHI learning, 2001.
2. W. Tomasi, *Electronic Communication Systems- Fundamentals Theory Advanced*, 4th ed., Pearson Education, 2001.
3. A.M. Dhake, *Television and Video Engineering*, McGraw Hill Publications, 2008.
4. B. Carlson, *Principles of Digital Communication*, Tata McGraw Hill, 2008.
5. Taub and Schilling, *Principles of Communication systems*, 4th ed., Tata McGraw Hill, India, 2017.
6. W. Stallings, *Cryptography and Network Security - Principles and Practices*, 3rd ed., PHI Learning, 2008.
7. J. G. Proakis, *Digital Communications*, McGraw Hill Publications, 2008.

Online Study Material

Websites:

- MIT OpenCourseWare: Communication Systems Courses

- NPTEL: Analog Communication
- Khan Academy: Digital Signals and Systems
- Coursera: Communication Systems Courses

Video Resources:

- YouTube channels like "Neso Academy" and "The Engineering Concepts"
- Online platforms like Coursera, Udacity, and edX offer courses on communication systems.

Simulation Tools:

- MATLAB or Simulink for simulating analog and digital communication systems.
- Online platforms providing interactive simulations for communication systems.

Additional Resources:

- Access to research papers and case studies in the field of communication systems.
- Participation in communication system design projects.

AVAS355 (AV5MI13): ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR AVS

L	T	P	C	45L
3	1	0	4	

Prerequisites

- Basic understanding of computer science fundamentals.
- Familiarity with programming languages, preferably Python.
- Knowledge of algorithms and data structures.
- Understanding of mathematical concepts, including probability and statistics.
- Understand the various characteristics of a problem-solving agent

Course Objective

- Introduce the fundamental principles and concepts of artificial intelligence (AI).
- Teach the basics of problem-solving using AI techniques.
- Explore machine learning algorithms and their applications.
- Enable students to understand natural language processing and computer vision.
- Focus on practical applications of AI in various domains.

Course Outcome

- Understanding of the basic principles and history of artificial intelligence.
- Proficiency in applying AI techniques for problem-solving.
- Capability to analyse and design machine learning models.
- Ability to implement natural language processing and computer vision systems.
- Skills to apply theoretical concepts to practical AI problems.

Unit I: Introduction to Al & Production Systems **9**

Introduction - AI problems, foundation of AI and history of AI intelligent agents - Agents and Environments - the concept of rationality, the nature of environments, structure of agents, problem-solving agents, problem formulation.

Unit II: Searching Techniques **9**

Searching-Searching for solutions, uniformed search strategies – Breadth-first search, depth-first Search. Search with partial information (Heuristic search) Greedy best-first search- A* search Game Playing- Adversial search, Games, minimax, algorithm, optimal decisions in multiplayer games, AlphaBeta pruning, Evaluation functions, cutting of search.

Unit III: Representation of Knowledge **9**

Knowledge Representation & Reasons logical Agents, Knowledge-based Agents, the Wumpus world, logic, propositional logic, Resolution patterns in propositional logic, Resolution, Forward & Backward Chaining.

Unit IV: First Order Logic **9**

Inference in first-order logic, propositional vs. first-order inference, unification & lifts forward chaining, Backward chaining, Resolution - Learning - Learning from observations – forms of learning.

Unit V: An Overview of Prolog **9**

An example program: defining family relations - Extending the example program by rules -A recursive rule definition - How Prolog answers questions - Declarative and procedural meaning of programs - Syntax and Meaning of Prolog Programs - Lists, Operators, Arithmetic - Using Structures: Example Programs.

TEXTBOOK

1. E. Rich, K. Knight, *Artificial Intelligence*, 2nd edition, TMH, 2005.
2. S. Russel, P. Norvig, *AI – A Modern Approach*, 2nd edition, Pearson Education, 2007.
3. D. L. Poole and A. K. Mackworth, *Artificial Intelligence: Foundations of Computational Agents*. 2nd edition, Cambridge University Press, 2017.

REFERENCE BOOKS

1. K. P. Murphy, *Machine Learning: A Probabilistic Perspective*. Cambridge, MA: MIT Press, 2012.
2. I. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning. Cambridge*, MA: MIT Press, 2016.
3. M. Mitchell, *Artificial Intelligence: A Guide for Thinking Humans*. New York, NY: Farrar, Straus and Giroux, 2019.
4. R. S. Sutton and A. G. Barto, *Reinforcement Learning: An Introduction*. 2nd edition, Cambridge, MA: MIT Press, 2018.
5. M. Negnevitsky, Artificial Intelligence: A Systems Approach. 2nd edition, Boston, MA: Addison-Wesley, 2005.

Online Study Material

Websites:

- Coursera: AI and Machine Learning Courses
- edX: Artificial Intelligence Courses
- Khan Academy: Introduction to Machine Learning
- TensorFlow and PyTorch documentation for deep learning.

Video Resources:

- YouTube channels like "3Blue1Brown" and "Sentdex"
- Online platforms like Coursera, Udacity, and edX offer courses on artificial intelligence.

Practical Platforms:

- Kaggle for real-world data science and machine learning projects.
- Colab or Jupyter Notebooks for experimenting with AI algorithms.

Additional Resources:

- Access to AI research papers and conferences.
- Participation in AI hackathons and competitions.

AVAS355 (AV5MI14): INDUSTRIAL MANAGEMENT

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic understanding of business and management concepts.
- Familiarity with organizational behaviour and principles of economics.
- Knowledge of production systems and manufacturing processes.
- Understanding of basic financial and accounting principles.

Course Objective

- Introduce the fundamental principles of industrial management.
- Teach the principles of organizational structure and behavior.
- Explore techniques for effective resource management in industrial settings.
- Enable students to understand production planning and control.
- Focus on practical applications of industrial management in improving efficiency and productivity.

Course Outcome

- Understanding of the basic principles and history of industrial management.
- Proficiency in organizational structure, behavior, and leadership.
- Capability to apply management techniques for resource optimization.
- Ability to analyse and design production planning and control systems.
- Skills to apply theoretical concepts to practical industrial management problems.

Unit I: Principles of Management **9**

Management Concept-Types and principles of management - scientific management- types and functions of organization - merits and demerits- elements of management- planning, organizing, staffing, directing, and control. Types of ownership-sole proprietorships-partnership- private and public limited companies-Advantages and disadvantages.

Unit II: Financial Management **9**

Sources of finance - internal and external - types of investment- Evaluation of Investments preparation of balance sheet and profit and loss statement - managing working capital – types of accounting and significance of each type-Type of costs, total costs, Average costs, Marginal costs, Break-even analysis.

Unit III: Production and Materials Management **9**

Types of production -process planning scheduling, Routing- Functions and objects of materials management - stores and material control- Inventory planning and control - functions of inventories.

Unit IV: Sales and Marketing **9**

Core concepts of marketing needs, wants and demand-marketing Vs selling-products and markets- pricing and its related factor- basic concepts in channels of distribution – sales promotion -Advertising-Market research - sales forecasting.

Unit V: Industrial Psychology and Personal Management **9**

Definition, scope of Industrial psychology - Individual and group-motive and morale. Fatigue, causes and remedy-accidents causes and prevention- manpower planning, job analysis and merit rating- wage and salary administration - causes of Industrial unrest - collective bargaining - (MBO) management by objectives - concepts, advantages and limitations of MBO.

TEXTBOOK

1. J.S. Chandan, *Management - Theory and Practice*, Vikas publications, 2002.
2. J. Massie, Essential of Management, 4th edition, Prentice Hall, 2001.
3. H. Koontz, C. O'Donnell, H. Weihrich, *Management*. 8th edition, McGraw Hill, 1984.
4. I. M. Pandy, *Financial Management*, 11th edition, Vikas Publishing House, 2015.
5. A. Monappa and M. Saiyadi, *Personnel Management*. 2nd edition, Tata Mc Graw Hill New, 2010.

AVAS355 (AV5MI15): INDUSTRY 4.0 AND INDUSTRIAL INTERNET OF THINGS

L	T	P	C	45L
3	1	0	4	

Prerequisites

- Basic understanding of industrial processes and manufacturing.
- Knowledge of automation systems and technologies.
- Familiarity with networking concepts and protocols.
- Proficiency in basic programming or scripting languages.
- Understanding of data analytics and cloud computing basics.

Course Objective

- Introduce the concepts and principles of Industry 4.0 and IIoT.
- Explore the integration of cyber-physical systems in industrial applications.
- Teach the role of sensors, actuators, and connectivity in smart manufacturing.
- Enable students to understand the potential of data analytics and AI in Industry 4.0.
- Focus on the impact and benefits of digital transformation in industrial settings.

Course Outcome

- Understanding of the key technologies driving Industry 4.0 and IIoT.
- Proficiency in identifying and implementing IIoT solutions in industries.
- Capability to analyse and design cyber-physical systems for industrial use.
- Ability to assess the challenges and opportunities in Industry 4.0 adoption.
- Skills to contribute to the advancement of smart manufacturing processes.

Unit I: Introduction **9**

Sensing & actuation, Communication-Part I, Part II, Networking-Part I, Part II**,** Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories.

Industry 4.0: Cyber-Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis.

Unit II: Cybersecurity in Industry 4.0 **9**

Basics of Industrial IoT: Industrial Processes-Part I, Part II, Industrial Sensing & Actuation, Industrial Internet Systems.

IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business ModelsPart I, Part II, IIoT Reference Architecture-Part I, Part II. Industrial IoT- Layers: IIoT Sensing-Part I, Part II, IIoT Processing-Part I, Part II.

IIoT Communication-Part I. Industrial IoT- Layers: IIoT Communication-Part II, Part III, IIoT Networking-Part I, Part II, Part III.

Unit III: ML in Industrial IoT **9**

Big Data Analytics and Software Defined Networks: IIoT Analytics - Introduction, Machine Learning and Data Science - Part I, Part II, R and Julia Programming, Data Management with Hadoop.

Industrial IoT: Big Data Analytics and Software Defined Networks: SDN in IIoT-Part I, Part II, Data Center Networks, Industrial IoT: Security and Fog Computing: Cloud Computing in IIoT-Part I, Part II.

Unit IV: Industrial IoT **9**

Industrial IoT: Security and Fog Computing - Fog Computing in IIoT, Security in IIoT-Part I, Part II, Industrial IoT- Application Domains: Factories and Assembly Line, Food Industry. Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management.

Unit V: Industrial IoT- Application Domains **9**

Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies.

TEXTBOOK

1. S. Misra, A. Mukherjee, and A. Roy, Introduction to IoT. Cambridge University Press, 2020.
2. S. Misra, C. Roy, and A. Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0. CRC Press.2020.
3. Dr. Guillaume Girardin, Antoine Bonnabel, Dr. Eric Mounier, 'Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024', Yole Development Copyrights, 2014.
4. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015.
5. "Industry 4.0: The Industrial Internet of Things" by Alasdair Gilchrist.

REFERENCE BOOKS

1. "Industry 4.0: An Introduction" by Henning Kagermann, Wolfgang Wahlster, Johannes Helbig
2. "The Industrial Internet of Things (IIoT): Concepts, Technologies, Applications" by Paulo Leitão, Stamatis Karnouskos
3. "Industry 4.0: Smart Manufacturing for the Future" by Banerjee, Sarkar, Das, & Deb
4. "Smart Manufacturing: Industrial and Management Engineering" by Taehan Lee, Cheol Han.
5. "Internet of Things (IoT) in 5G Mobile Technologies" by Sasikumar Gurumoorthy, Lalit M. Patnaik.

Online Study Material

Websites:

- Coursera: Industry 4.0 and IIoT Courses and Specializations
- edX: Smart Manufacturing and IIoT Fundamentals
- Industrial Internet Consortium (IIC) Resources and Publications
- IEEE Industrial Electronics Society resources

Video Resources:

- YouTube channels like "The IoTLearningInitiative" and "Industry 4.0 TV"
- Online platforms like Coursera, Udacity, and edX offer courses on Industry 4.0 and IIoT.

Whitepapers and Case Studies:

- Access to industry-specific whitepapers and case studies on IIoT implementations.
- Research papers on the applications and challenges of Industry 4.0.

Additional Resources:

- Participation in IIoT workshops and seminars.
- Access to IoT development kits and platforms for hands-on experience.
- Collaboration with professionals and researchers in the Industry 4.0 domain.

AVAS354 (AV5MJ12): SPACE TECHNOLOGY FOR AVS

L	T	P	C	45L
3	1	0	4	

Prerequisites: NIL

Course Objective

- Learn about fundamental laws that govern the orbital dynamics, equations for satellite dynamics, basics of different orbits.
- Learn about the description of Keplerian orbital elements, satellite position and motion within the orbit, factors that cause orbit perturbation.
- Learn the different types of satellite orbit transfer from one orbit to an another, basics of inter-planetary trajectory.
- Learn the governing equations of rocket flight dynamics, different flight phases, injection of satellite, injection errors on orbit.
- Learn about equations of ballistic missile trajectory, impact point error analysis.

Course Outcome

- Understanding of fundamental concepts related to space technology.
- Identify and describe the key components and systems of spacecraft.
- Understand the principles of orbital dynamics.
- Familiar with different types of launch vehicles, their capabilities, and the processes involved in launching spacecraft into orbit.
- Understand the process of designing space missions, including mission objectives, payload requirements, trajectory design, mission planning, and risk assessment.

Unit I: Orbital Mechanics Fundamentals **9**

Laws of orbital dynamics, Solar system, Earth geometry and structure of upper atmosphere. Multi-body problem, Two-body problem; Equation of motion, Orbit equation; Motion in circular, elliptical orbits, parabolic, hyperbolic orbits, Interplanetary trajectories.

Unit II: Orbits in Three Dimensions **9**

Coordinate systems, Time systems; Keplerian Orbital elements; Relations between position and time, Keplers equation; Effects of the earth's oblateness, Types of satellite orbits, their characteristics and applications; Orbit perturbation due to a third body, Orbit decay and lifetime.

Unit III: Orbital Transfer and Powered Flight **9**

Rocket equation, application to orbit transfer, velocity requirement, different propulsion systems, Propellant; Single and two Impulse transfer, Hohmann transfer; One tangent manoeuver, Plane change manoeuver, Bi-Elliptical manoeuver, Phasing manoeuver; Interplanetary missions.

Unit IV: Rocket Flight Dynamics **9**

One-dimensional and two-dimensional rocket motions in free space and homogeneous gravitational fields, fundamentals of three dimensional six degrees of freedom trajectory simulation, Description of vertical, inclined and gravity turn trajectories. Launching of a

satellite, orbital elements from injection state vector, injection error analysis; Multistage rocket systems, restricted staging.

Unit V: Ballistic Mission Trajectories **9**

Free-flight range equation, flight-path angle equation, maximum range trajectory; Time of free-flight, effect of earth rotation, relative velocity, inertial velocity; Effect of launching errors of state vector on the impact point.

TEXTBOOK

1. H. D. Curtis, *Orbital Mechanics for Engineering Students*. 3rd edition, Oxford, UK: Elsevier Butterworth-Heinemann, 2013.
2. J. W. Cornelisse, H. F. R. Schoyer, and K. F. Wakker, *Rocket Propulsion and Space Dynamic*. London, UK: Pitman Publishing Co., 1979.

REFERENCE BOOKS

1. R. R. Bate, D. D. Mueller, and J. E. White, *Fundamentals of Astrodynamics*. New York, NY: Dover Publications, 1972.
2. A. Tewari, *Atmospheric and Space Flight Dynamics*. Boston, MA: Birkhauser, 2007.
3. M. J. L. Turner, *Rocket and Spacecraft Propulsion*. 3rd edition, Chichester, UK: Springer-Praxis Publishing Co., 2009.
4. D. A. Vallado, *Fundamentals of Astrodynamics and Applications*, Space Technology Series. 4th edition, New York, NY: McGraw Hill, 2013.
5. V. A. Chobotov, *Orbital Mechanics*, 3rd edition, AIAA Education Series. Reston, VA: American Institute of Aeronautics and Astronautics, 2002.

Online Study Material

- NASA's Introduction to Space Technology Course
- MIT OpenCourseWare: Introduction to Aerospace Engineering
- European Space Agency (ESA) Education Office Resources
- Coursera: Introduction to Space Engineering
- Khan Academy: Astronomy and Cosmology
- SpaceX YouTube Channel
- NASA's Jet Propulsion Laboratory (JPL) Education
- edX: Spacecraft Dynamics and Control
- European Space Education Resource Office (ESERO)
- NASA's Space Technology Mission Directorate (STMD)

SIXTH SEMESTER

AVAS361 (AV6MJ13): CONTROL SYSTEMS FOR AVS

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic understanding of engineering fundamentals, particularly in mathematics and physics.
- Familiarity with linear algebra and differential equations.
- Knowledge of basic electrical circuits and systems.
- Understanding of programming concepts is beneficial but not mandatory.

Course Objective

- Introduce fundamental concepts of control systems and their applications.
- Teach the principles of modelling and analysis of dynamic systems.
- Explore different types of control systems, including feedback and feedforward control.
- Enable students to design and analyse control systems using various methods.
- Focus on practical applications of control systems in engineering.

Course Outcome

- Understanding of the basic principles and history of control systems.
- Proficiency in modelling and analysing dynamic systems.
- Capability to design and tune feedback control systems.
- Ability to apply control theory to real-world engineering problems.
- Skills to analyse and optimize the performance of control systems.

Unit I: System Modelling **9**

Introduction to control system-Basic elements in control system –Open and closed loop control systems – Differential equation representation of physical systems – Transfer function – Mathematical modelling of electrical and mechanical systems (Translational and Rotational) – Analogous system- Block diagram representation of systems- Block diagram reduction techniques – Signal flow graph-control system components-synchros -tachometer- dc and ac servomotors-stepper motors.

Unit II: Time Domain Analysis **9**

Standard test signals- First order system - step, ramp and impulse response analysis-Second order system – step response analysis- steady state error – generalized error co-efficient –Effect of adding a zero to the system- Principle of PI, PD and PID compensation-stability analysis – Routh Hurwitz criterion – Root locus method.

Unit III: Frequency Domain Analysis **9**

Frequency response –Frequency domain specifications – Correlation between time domain and frequency domain specifications-Bode plot – Stability analysis using Bode plot- transfer function from Bode plot-Polar plot – Nyquist stability criterion.

Unit IV: Digital Control System **9**

Basic digital control system –Spectrum analysis of sampling process –Signal reconstruction-Difference equation representation of digital control systems- Z transform and its properties –

Pulse transfer function-Inverse Z transform Response of linear discrete-time systems-Z transform analysis of sampled data control systems-Stability analysis – Jury's stability criterion.

Unit V: State Space Analysis **9**

Introduction – Concepts of state, state variables and state model– State model of linear systems– system realization-State space representation using physical, phase and canonical variables –diagonal canonical form-Jordan canonical form diagonalization- Time-domain solution of state equation-State transition matrix-Laplace transform solution of state equations-Derivation of transfer function from the state model Controllability and observability- State space representation of discrete-time systems.

TEXTBOOK

1. I. J. Nagrath, M. Gopal, *Control Systems Engineering*, 5th edition, New Age International, New Delhi, 2007.
2. K. Ogata, *Modern Control Engineering*. 5th edition, Pearson Education India, 2015.
3. N. S. Nise, *Control Systems Engineering*. Wiley, 2018.
4. B. C. Kuo, *Automatic Control Systems*. 9th edition, Wiley, 2014.
5. G. F. Franklin, J. D. Powell, and A. Emami-Naeini, *Feedback Control of Dynamic Systems*. 8th edition, Pearson, 2018.

REFERENCE BOOKS

1. B. C. Kuo, *Automatic Control Systems*, 7th edition, New Delhi, India: PHI Learning, 1997.
2. K. Ogata, *Discrete Time Control Systems*, 2nd edition, New Delhi, India: PHI Learning, 2006.
3. R. Anandanatarajan and P. Ramesh Babu, *Control Systems Engineering*, 2nd edition, Chennai, India: Scitech Publications Pvt. (India) Ltd, 2008.
4. K. J. Åström and R. M. Murray, *Feedback Systems: An Introduction for Scientists and Engineers*, Princeton University Press, 2008.
5. M. Gopal, *Control Systems: Principles and Design*, 4th edition, McGraw Hill Education, 2012.

Online Study Material

Websites:

- Khan Academy: Control Systems
- MIT OpenCourseWare: Introduction to Control Systems
- NPTEL: Control Engineering

Coursera: Control Systems Courses

Video Resources:

- YouTube channels like "Brian Douglas" and "Control System Lectures"
- Online platforms like Coursera, Udacity, and edX offer courses on control systems.

Simulation Tools:

- MATLAB or Simulink for simulating control systems.
- Online platforms providing interactive simulations for control theory.

Additional Resources:

- Access to research papers and case studies in the field of control systems.
- Participation in control system design projects.

CONTROL SYSTEMS FOR AVS LAB

List of Experiments **30**

1. Determination of transfer function parameters of Armature controlled DC (servo) motor.
2. Determination of transfer function parameters of Field controlled DC (servo) motor.
3. Determination of transfer function parameters of an AC servomotor.
4. Analog simulation of type-0 and type-1 systems.
5. Digital simulation of first-order systems.
6. Digital simulation of second-order systems.
7. Stability analysis of linear systems.
8. DC and AC position control systems.
9. Stepper motor control system
10. Determination of transfer function parameters of DC generators.
11. Study of synchros.
12. Design and implementation of compensators.
13. Design of P, PI and PID controllers.

TEXTBOOK

1. G. Huang, *PC-based PID speed control in DC Motor*, in Proc. IEEE International Conference on Control and Automation, 2008, ISBN: 978-1-4244-1723-0.
2. "*Control of Twin Rotor MIMO System (TRMS) Using PID Controller*," International Journal of Advance Engineering and Research Development, vol. 2, no. 1, 2015, ISSN: 2348-6406.

AVAS362 (AV6MJ14): INTERNET OF THINGS FOR AVS

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic understanding of computer networks and protocols.
- Familiarity with programming languages, preferably C, C++, or Python.
- Knowledge of electronics and sensor technologies.
- Understanding of data communication and cloud computing concepts.

Course Objective

- Introduce the fundamental concepts and principles of the Internet of Things (IoT).
- Teach the architecture and components of IoT systems.
- Explore communication protocols used in IoT devices and networks.
- Enable students to design and implement IoT solutions.
- To Understand the Architectural Overview of IoT

Course Outcome

- Understanding of the basic principles and history of the Internet of Things.
- Proficiency in designing and implementing IoT architectures.
- Capability to analyse and choose communication protocols for IoT devices.
- Ability to develop and deploy IoT applications.
- Skills to apply theoretical concepts to real-world IoT problems.

Unit I: Overview IoT **9**

An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management.

Unit II: Reference Architecture IoT **9**

Architecture-State of the Art – Introduction, State of the art, Reference Model and architecture, IoT reference Model - IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control.

Unit III: IoT Data Link Layer & Network Layer Protocols PHY/MAC **9**

Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART, Z Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH, ND, DHCP, ICMP, RPL, CORPL, CARP.

Unit IV: Transport & Session Layer Protocols **9**

Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer HTTP, CoAP, XMPP, AMQP, MQTT.

Unit V: Service Layer Protocols & Security **9**

Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4, 6LoWPAN, RPL, Application Layer.

TEXTBOOK

1. B. K. Tripathy and J. Anuradha, *Internet of Things (IoT) Technologies Applications Challenges and Solutions*, 1st edition, Boca Raton, FL: Taylor & Francis, 2017.
2. S. Cirani, G. Ferrari, M. Picone, and L. Veltri, *Internet of Things: Architectures, Protocols and Standards*, 1st edition, 2018.
3. A. Bahga and V. Madisetti, *Internet of Things: A Hands-On Approach*. 1st edition, New Delhi: Orient Blackswan Private Limited, 2015.
4. M. Kranz, *Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry*. 1st edition, Wiley, 2016.
5. A. McEwen and H. Cassimally, *Designing the Internet of Things*, 1st edition, Wiley, 2013.

REFERENCE BOOKS

1. J. Holler, V. Tsiatsis, C. Mulligan, S. Avesand, S. Karnouskos, and D. Boyle, *From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence*, 1st edition, Cambridge, MA: Academic Press, 2014.
2. P. Waher, *Learning Internet of Things*, 1st edition, Birmingham, UK: Packt Publishing, 2015.
3. B. Scholz-Reiter and F. Michahelles, *Architecting the Internet of Things*, 1st edition, Berlin, Germany: Springer, 2011, ISBN: 978-3-642-19156-5.
4. S. Greengard, *The Internet of Things*, 2nd edition, MIT Press, 2021.
5. P. Waher, IoT: Building Arduino-Based Projects, 1st edition, Packt Publishing Limited, 2016.

Online Study Material

Websites:

- IoT For All: Tutorials and Articles
- IEEE Internet of Things (IoT) Community
- Coursera: Internet of Things (IoT) Courses
- edX: Internet of Things (IoT) Courses

Video Resources:

- YouTube channels like "The IoT Learning Initiative" and "IoT Worm"
- Online platforms like Coursera, Udacity, and edX offer courses on the Internet of Things.

Practice Platforms:

- IoT development kits (Arduino, Raspberry Pi) for hands-on experience.
- Online IoT simulation tools for experimenting with IoT concepts.

Additional Resources:

- Access to IoT project repositories and open-source IoT solutions.
- Participation in IoT hackathons and workshops.
- Neworking with professionals in the IoT industry.

INTERNET OF THINGS FOR AVS LAB

Program Outcome

At the end of the course, the student shall be able to

- Analyse the concepts of IoT along with its applications.
- Design a prototype using Arduino Uno.
- Analyse different types of sensors, actuators and communication Protocols.
- Execute a prototype of Home Automation using the Blynk app.
- Design an IoT application to interact with the cloud.

List of Experiments (Any 10) **30**

1. Study the fundamentals of IOT software and components.
2. Familiarization with Arduino/Raspberry Pi and perform necessary software.
3. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
4. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
5. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
6. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
7. To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
8. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
9. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when _1‘/‘0‘ is received from smartphone using Bluetooth.
10. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thing speak cloud.
11. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thing speak cloud.
12. To install MySQL database on Raspberry Pi and perform basic SQL queries.
13. Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested.
14. Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.

AVAS363 (AV6MJ15): COMPUTATIONAL FLUID DYNAMICS

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Fundamental knowledge of fluid mechanics and thermodynamics.
- Proficiency in mathematics, including calculus, differential equations, and linear algebra.
- Familiarity with numerical methods and programming languages, such as MATLAB or Python.
- Understanding of engineering principles and applications.

Course Objective

- Introduce the principles and fundamentals of Computational Fluid Dynamics.
- Teach the mathematical models used in CFD for fluid flow analysis.
- Explore numerical methods for solving fluid flow problems.
- Enable students to use CFD software for simulation and analysis.
- To introduce Governing Equations of viscous fluid flows.

Course Outcome

- Understanding of the basic principles and applications of Computational Fluid Dynamics.
- Proficiency in applying mathematical models for fluid flow simulation.
- Capability to use CFD software for solving complex fluid flow problems.
- Ability to analyse and interpret CFD results for engineering applications.
- Skills to apply CFD techniques to real-world engineering challenges.

Unit I: Governing Equations and Boundary Conditions **9**

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

Unit II: Finite Difference Method **9**

Derivation of finite difference equations – Simple Methods – General Methods for first and second-order accuracy – solution methods for finite difference equations – Elliptic equations – Iterative solution Methods – Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations.

Unit III: Finite Volume Method (FVM) For Diffusion **9**

Finite volume formulation for steady state One, Two and Three-dimensional diffusion problems. One-dimensional unsteady heat conduction through Explicit, Crank – Nicolson and fully implicit schemes.

Unit IV: Finite Volume Method for Convection Diffusion **9**

Steady one-dimensional convection and diffusion – Central, upwind differencing properties of discretization schemes – Conservativeness, Boundedness, Trasnportiveness, Hybrid, Power-law, QUICK Schemes.

Unit V: Calculation Flow Field by FVM **9**

Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants. Turbulence models, mixing length model, Two equation (k-ε) models – High and low Reynolds number models.

TEXTBOOK

1. T.J. Chung, *Computational Fluid Dynamics*, Cambridge University, Press, 2002.
2. H. K. Versteeg, and W. Malalasekera, *An Introduction to Computational Fluid Dynamics: The finite volume Method*, 2nd edition, Longman, PHI, 2007.
3. A. Sharma, *Introduction to Computational Fluid Dynamics*, Springer International Publishing AG, Cham, 2021.
4. J. Tu, G. H. Yeoh, and C. Liu, *Computational Fluid Dynamics: A Practical Approach*, 4th edition, Butterworth-Heinemann, Amsterdam, 2023.

REFERENCE BOOKS

1. S.V. Patankar, *Numerical Heat Transfer and Fluid Flow*, Hemisphere Publishing Corporation, 2004.
2. K. Muralidhar and T. Sundararajan, *Computational Fluid Flow and Heat Transfer*, Narosa Publishing House, New Delhi, 1995.
3. P.S. Ghoshdastidar, *Heat Transfer*, Oxford University Press, 2005.
4. P. Niyogi, S.K. Chakrabarty, and M.K. Laha, *Introduction to Computational Fluid Dynamics*, Pearson Education, 2005.
5. A. W. Date, *Introduction to Computational Fluid Dynamics*, Cambridge University Press, 2005.

Online Study Material

Websites:

- Fluent Learning: ANSYS CFD Tutorials
- OpenFOAM Documentation: Open Source CFD Software
- MIT OpenCourseWare: Introduction to CFD
- Coursera: Computational Fluid Dynamics Courses

Video Resources:

- YouTube channels like "LearnCAx" and "CFD NINJA"
- Online platforms like Coursera, Udacity, and edX offer courses on Computational Fluid Dynamics.

Simulation Tools:

- ANSYS Fluent, OpenFOAM, or other CFD software for hands-on experience.
- Online platforms providing interactive CFD simulations.

Additional Resources:

- Access to research papers and case studies in the field of CFD.
- Participation in CFD competitions and workshops.

- Collaboration with industry professionals working in the field of Computational Fluid Dynamics.

COMPUTATIONAL FLUID DYNAMICS LAB

Program Outcome

At the end of the course, the student will be able to

- demonstrate modeling of the double pipe heat exchanger, simple exhaust system and aerofoil using ANSYS Design Modeler (L3)
- solve steady, unsteady state heat conduction in slabs and steady state heat conduction through fins (L3)
- solve problems of laminar forced convection over flat plate, cylinder and through a pipe (L3)
- solve problems of turbulent forced convection over flat plate, cylinder, airfoil and through a pipe/helical pipe (L3)
- analyse heat transfer to a fluid by natural convection from a flat plate, radiation heat transfer between two parallel plates (L4)

List of Exercises (Any **twelve** using ANSYS/OpenFOAM**)** **30**

1. Demonstration of double pipe heat exchanger modeling using ANSYS Design Modeler.
2. Demonstration of simple exhaust system modeling using ANSYS Design Modeler.
3. Demonstration of airfoil modeling using ANSYS Design Modeler.
4. Steady state heat transfer through a rectangular slab.
5. Steady state heat transfer through a composite rectangular slab.
6. Unsteady state heat conduction in a rectangular slab.
7. Heat transfer from a rectangular fin.
8. Heat transfer from a triangular fin.
9. Forced convection heat transfer over a horizontal flat plate.
10. Laminar forced convection in a pipe.
11. Turbulent forced convection in a pipe.
12. Forced convection heat transfer across a horizontal cylinder.
13. Natural convection heat transfer from a vertical plate.
14. Forced convection in a helical coil.
15. Flow over an airfoil.
16. Radiation heat transfer between two vertical parallel plates.

CFD Software: ANSYS/ OpenFOAM

References (weblinks)

https://www.youtube.com/watch?v=p-Ch3gGgeuE (Experiment 14)
https://www.youtube.com/watch?v=grZ9FesmW6I (Experiment 16)

AVAS364 (AV6MJ16): KINEMATICS AND DYNAMICS OF MACHINES

L	T	P	C	45L
3	1	0	4	

Prerequisites: NIL

Course Objective

- To understand the basic knowledge about kinematics of machines.
- To understand the basic components and layout of linkages in the assembly of a system/ machine.
- To understand the principles in analysing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
- To understand the motion resulting from a specified set of linkages, design few linkage
- Mechanisms and cam mechanisms for specified output motions

Course Outcome

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

- Understand the basic knowledge of kinematics of machines
- Students can apply fundamentals of mechanism for the design of new mechanisms
- Know about the linkages, design few linkage mechanisms and cam mechanisms for specified output motions
- Impart knowledge about the gears and gear trains
- Analyse them for optimum design

Unit I: Kinematic of Machines **9**

Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – kinematics analysis in simple mechanisms – velocity and acceleration polygons – Analytical methods – computer approach – cams – classifications – displacement diagrams - layout of plate cam profiles – derivatives of followers motion – circular arc and tangent cams.

Unit II: Gears and Gear Trains **9**

Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains – automotive transmission gear trains.

Unit III: Friction **9**

Sliding and Rolling Friction angle – friction in threads – Friction Drives –Belt and rope drives.

Unit IV: Kinematics of Cam Mechanisms **9**

Classification of cams and followers – Terminology and Definitions – Displacement Diagrams- Uniform velocity, Parabolic, Simple Harmonic and cycloid motions – Derivatives of follower motions – Layout of plate cam profiles – Specified Contour cams – Circular arc and tangent cams – Pressure angle and undercutting – Sizing of cams.

Unit V: Balancing and Vibration **9**

Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines – free vibrations – Equations of motion – natural Frequency – Damped Vibration bending critical speed of simple shaft.

TEXTBOOK

1. A.G. Ambekar, *Mechanism and Machine Theory*, Prentice Hall of India, New Delhi, 2007.
2. J.E. Shigley, G.R. Pennock, and J.J. Uicker, *Theory of Machines and Mechanisms*, Oxford University Press, 2003.

REFERENCE BOOKS

1. T. Bevan, *Theory of Machines*, 3rd edition, CBS Publishers and Distributors, 2005.
2. A. Ghosh and A.K. Mallick, *Theory and Machine*, 2nd edition, Affiliated East-West Pvt. Ltd., New Delhi, 1988.
3. J.S. Rao and R.V. Dukkipatti, *Mechanisms and Machines*, 2nd edition, Wiley-Eastern Ltd., New Delhi, 1992.
4. J. Hannah and R.C. Stephens, *Mechanics of Machines*, Viva Low Prices Student Edition, 1999.
5. V. Ramamurthi, *Mechanisms of Machine*, 3rd edition, Narosa Publishing House, 2009.
6. R.L. Norton, *Design of Machinery*, 3rd edition, McGraw-Hill, 2004.

Online Study Material

Websites:

- NPTEL: Dynamics of Machines
- Khan Academy: Physics - Mechanics
- Coursera: Mechanical Engineering Courses
- edX: Dynamics of Machines Courses

Video Resources:

- YouTube channels like "Structurefree" and "Jeff Hanson"
- Online platforms like Coursera, Udacity, and edX offer courses on dynamics of machinery.

Simulation Tools:

- MATLAB or Simulink for simulating machine dynamics.
- Online platforms providing interactive simulations for machine components.

Additional Resources:

- Access to research papers and case studies in the field of dynamics of machinery.
- Participation in machine design projects and competitions.
- Exploration of industry standards related to machine dynamics.

AVAS365 (AV6MI16): MANUFACTURING PROCESSES

L	T	P	C	45L
3	0	2	4	

Prerequisites: NIL

Course Objective

- Understanding Manufacturing Processes**,** Material Selection and Processing**,** Process Optimization.
- Quality Control and Assurance: Introduce students to quality control and assurance methods used in manufacturing, including inspection techniques, statistical process control (SPC), and quality management systems (e.g., ISO standards).
- Safety and Environmental Considerations.
- Problem-Solving Skills**,** Hands-on Experience.
- Industry Integration**,** Communication and Collaboration**,** Professional Development**.**

Course Outcome

- Demonstrate Knowledge**,** Apply Concepts**.**
- Evaluate Performance**,** Optimize Processes.
- Ensure Quality and troubleshoot Issues.
- Demonstrate Skills**,** Communicate Effectively.
- Collaborate in Teams**,** Adapt to Change.

Unit I: Metal Casting Processes **9**

Sand Casting – Sand Mould – Type of patterns – Pattern Materials – Pattern allowances – Molding sand Properties and testing – Cores –Types and applications – Molding machines – Types and applications – Melting furnaces – Principle of special casting processes- Shell, investment – Ceramic mould – Pressure die casting – low pressure, gravity- Tilt pouring, high pressure die casting- Centrifugal Casting – CO2 casting –- Defects in Sand casting process-remedies.

Unit II: Metal Joining Processes **9**

Fusion welding processes – Oxy-fuel welding – Filler and Flux materials-–Arc welding, Electrodes, Coating and specifications – Gas Tungsten arc welding –Gas metal arc welding – Submerged arc welding – Electro slag welding– Plasma arc welding — Resistance welding Processes -Electron beam welding –Laser beam Welding Friction welding – Friction stir welding – Diffusion welding – Thermit Welding, Weld defects – inspection &remedies – Brazing – soldering – Adhesive bonding.

Unit III: Bulk Deformation Processes **9**

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – cold forging- Characteristics of the processes – Typical forging operations – rolling of metals – Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts – Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion. Introduction to shaping operations.

Unit IV: Sheet Metal Processes **9**

Sheet metal characteristics – Typical shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes – Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning – Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming – Incremental forming.

Unit V: Manufacture Of Plastic Components **9**

Types and characteristics of plastics – Molding of thermoplastics & Thermosetting polymers– working principles and typical applications – injection moulding – Plunger and screw machines – Compression moulding, Transfer Molding – Typical industrial applications – introduction to blow molding – Rotational molding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics- duff moulding.

TEXTBOOK

1. S. Kalpakjian and S.R. Schmid, *Manufacturing Engineering and Technology*, 7th ed., Wiley, 2018.
2. S. Kalpakjian and S.R. Schmid, *Manufacturing Processes for Engineering Materials*, 6th ed., Pearson, 2018.
3. M.P. Groover, *Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*, 6th ed., Wiley, 2015.
4. R. Thompson, *Manufacturing Processes for Design Professionals*, 1st ed., Thames & Hudson, 2007.
5. J.A. Schey, *Introduction to Manufacturing Processes*, 3rd ed., McGraw-Hill, 1999.

REFERENCE BOOK

1. E.P. Degarmo, J.T. Black, and R.A. Kohser, *Materials and Processes in Manufacturing*, 11th ed., Wiley, 2017.
2. R.H. Todd, D.K. Allen, and L. Alting, *Manufacturing Processes Reference Guide*, 1st ed., Industrial Press Inc., 1994.
3. H. Geng (Ed.), *Manufacturing Engineering Handbook*, 2nd ed., McGraw-Hill, 2015.
4. T. Drozda (Ed.), *Tool and Manufacturing Engineers Handbook*, 5th ed., Society of Manufacturing Engineers, 1998.
5. D.A. Stephenson and J.S. Agapiou, *Metal Cutting: Theories and Models*, 3rd ed., CRC Press, 2016.

AVAS365 (AV6MI17): POWER SOURCE AND IC ENGINES

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic understanding of thermodynamics and fluid mechanics.
- Familiarity with basic mechanical engineering concepts.
- Knowledge of physics and mathematics, including calculus.
- Understanding of basic energy conversion principles.

Course Objective

- Introduce fundamental concepts of power sources and energy conversion.
- Teach the principles of internal combustion engines and their working.
- Explore various types of power sources, including renewable and non-renewable.
- Enable students to analyse and design simple power systems.
- Focus on practical applications of power sources in different industries.

Course Outcome

- Understanding of the basic principles and history of power sources.
- Proficiency in analysing and designing internal combustion engines.
- Capability to evaluate different types of power sources.
- Ability to apply theoretical concepts to practical power system problems.
- Skills to analyse and optimize the performance of power systems.

Unit I: IC Engines and Power Generation Systems **9**

Working principles of IC engines – Classification – Diesel and petrol engines: two-stroke and four-stroke engines. Steam generators (Boilers) – Classification – Constructional features (of only low-pressure boilers) – Boiler mountings and accessories.

Conventional Power Generation Systems: Hydraulic, steam and gas turbines power plants – Schemes and layouts – Selection criteria of above power plants.

Unit II: Non-Conventional Energy Systems **9**

Non-Conventional Energy Systems (Description Only): Solar thermal systems – Solar photovoltaic – Solar Pond – wind, wave, tidal, geothermal and ocean thermal energy conversion systems.

Unit III: Batteries **9**

Principles and construction of lead-acid battery. Characteristics of battery, rating capacity and efficiency of batteries. Various tests on battery condition, charging methods. The constructional aspect of alkaline battery.

Unit IV: Primary and Secondary Batteries **9**

Description of primary and secondary batteries and their role in the energy system: different battery chemistries, concepts describing the storage capabilities of batteries in context of both energy and power.

Unit V: Modelling Techniques **9**

Different modelling techniques from atomic to systems level. How an electric power system can affect the operation of a battery, for example, in a vehicle or for large-scale storage.

TEXTBOOK

1. B. Heywood, *Internal Combustion Engine Fundamentals*, 2nd, McGraw-Hill Education, 2018
2. J. E. Duffy, *Automotive Engines: Theory and Servicing*, 8th, Pearson, Year: 2015
3. R. Stone, *Introduction to Internal Combustion Engines*, 4th, Palgrave Macmillan, 2012
4. P. Breeze, *Power Generation Technologies*, 2nd, Newnes, 2014
5. Nagpal, *Power Plant Engineering*, Khanna Publishers, Delhi, 1998.
6. J.B. Heywood, *Internal Combustion Engine Fundamentals*, 2nd ed., McGraw-Hill, 2018.

REFERENCE BOOKS

1. W. W. Pulkrabek, *Engineering Fundamentals of the Internal Combustion Engine*, 2nd, Pearson, 2003
2. R. D. Reitz, L. M. Pickett, and R. P. Duraisamy, *Advanced Internal Combustion Engines*, 1st, SAE International, 2020
3. J. L. Kirtley Jr., *Electric Power Principles: Sources, Conversion, Distribution and Use*, 1st, Wiley-IEEE Press, 2010
4. A. von Meier, *Electric Power Systems: A Conceptual Introduction*, 1st, Wiley-IEEE Press, 2006
5. M.M. El.Wakil, *Power Plant Technology*, McGraw Hill Book Co., 1985.

Online Study Material

Websites:

- NPTEL: Introduction to Internal Combustion Engines
- Khan Academy: Thermodynamics and Fluid Mechanics
- Coursera: Power Systems Courses
- edX: Mechanical Engineering Courses

Video Resources:

- YouTube channels like "Engineering Explained" and "Learn Engineering"
- Online platforms like Coursera, Udacity, and edX offer courses on power systems and internal combustion engines.

Simulation Tools:

- MATLAB or Simulink for simulating power systems and engines.
- Online platforms providing interactive simulations for internal combustion engines.

Additional Resources:

- Access to research papers and case studies in the field of power systems and internal combustion engines.
- Participation in engineering forums and conferences.
- Exploration of industry standards and regulations related to power systems.

AVAS365 (AV6MI18): RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS

L	T	P	C	45L
3	1	0	4	

Prerequisites

- Basic understanding of legal concepts and principles.
- Familiarity with business and technology.
- Appreciation of the role of innovation in various fields.

Course Objective

- Introduce the fundamental principles of intellectual property (IP) rights.
- Explore the various types of intellectual property, including patents, trademarks, copyrights, and trade secrets.
- Teach the legal framework for protecting and enforcing intellectual property.
- Enable students to understand the economic and social implications of intellectual property.
- Focus on practical applications and real-world cases in the field of intellectual property.

Course Outcome

- Understanding of the different types of intellectual property and their characteristics.
- Proficiency in evaluating and applying intellectual property laws.
- Capability to identify, protect, and manage intellectual property assets.
- Ability to analyse and discuss ethical and legal challenges in intellectual property.
- Skills to apply theoretical concepts to real-world situations in intellectual property.

Unit I: Research Problem **9**

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for the research problem, data collection, analysis, interpretation, and Necessary instrumentations.

Unit II: Literature Review **9**

Effective literature studies approaches, analysis Plagiarism, Research ethics.

Unit III: Technical Writing **9**

Effective technical writing, how to write a report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit IV: Nature of Intellectual Property **9**

Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit IV: Nature of Intellectual Property **9**

Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, and development. International Scenario: International Cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit V: Patent Rights **9**

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TEXTBOOK

1. R. Kumar, *Research Methodology: A Step-by-Step Guide for Beginners*, 4th edition, SAGE Publications, 2023.
2. J.W. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 5th edition, SAGE Publications, 2018.
3. W.C. Booth, G.G. Colomb, and J.M. Williams, *The Craft of Research*, 4th edition, University of Chicago Press, 2016.
4. S. Vaidhyanathan, *Intellectual Property: A Very Short Introduction*, 2nd edition, Oxford University Press, 2017.
5. D.E. Bouchoux, *Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets*, Cengage Learning, 2012.

REFERENCE BOOKS

1. R. Stim, *Intellectual Property: Patents, Trademarks, and Copyright*, Nolo, 2012.
2. D.S. Chisum, T.T. Ochoa, S. Ghosh, and M. LaFrance, *Understanding Intellectual Property Law*, 2nd edition, LexisNexis, 2011.
3. G. Dutfield, *Global Intellectual Property Law*, 2nd edition, Edward Elgar Publishing, 2020.
4. H. Grosse Ruse-Khan, *Intellectual Property: A Guide for Engineers*, Routledge, 2001.
5. Mayall, *Industrial Design*, McGraw Hill, 1992.
6. Niebel, *Product Design*, McGraw Hill, 1974.
7. Asimov, *Introduction to Design*, Prentice Hall, 1962.
8. R.P. Merges, P.S. Menell, and M.A. Lemley, *Intellectual Property in New Technological Age*, Wolters Kluwer, 2016.

Online Study Material

Websites:

- WIPO Academy: e-Learning on Intellectual Property
- World Intellectual Property Organization (WIPO) website
- United States Patent and Trademark Office (USPTO) website
- Coursera: Intellectual Property Courses

Video Resources:

- YouTube channels like "WIPO" and "INTA (International Trademark Association)"
- Online platforms like Coursera, edX, and Udemy offer courses on intellectual property.

Additional Resources:

- Access to case studies, legal texts, and IP-related journals.
- Participation in intellectual property conferences and seminars.

AV6VA6: ENTREPRENEURSHIP AND E-BUSINESS

L	T	P	C	30L
2	0	2	2	

Prerequisites

- Basic understanding of business and management concepts.
- Familiarity with marketing and finance fundamentals.
- Knowledge of information technology and the internet.
- Understanding of economic principles and market dynamics.

Course Objective

- Introduce the fundamental concepts of entrepreneurship and e-business.
- Teach the principles of business planning and strategy.
- Explore the role of technology and the internet in business innovation.
- Enable students to understand the challenges and opportunities in e-business.
- Focus on practical applications of entrepreneurship in the digital era.

Course Outcome

- Understanding of the basic principles and history of entrepreneurship and e-business.
- Proficiency in business planning and strategy development.
- Capability to analyse and utilize technology for business innovation.
- Ability to apply entrepreneurial concepts to real-world business challenges.
- Skills to develop and implement e-business strategies.

Unit I: Introduction **6**

Concept of Entrepreneurship - need and scope for entrepreneurship - Entrepreneur and society - qualities of entrepreneur Risks, relevance and benefits of small-scale Industry - definition of tiny, small ancillary industry - prevailing industrial policy of SSI - incentives and benefits of SSI units.

Unit II: Motivation Theories and Model **6**

Motivation theories - Maslow, McCllend - Motivation model - need, want, motive and behaviour - attitude towards work - self-assessment and goal setting - Achievement, motivation and behaviour measurement, SWOT analysis, TA analysis - Stress and conflict management; coping with uncertainty; creativity and innovation.

Unit III: Project Identification and Formulation **6**

Sources of information - opportunity guidance - choice of technology and its evaluation; Consumer behaviour; market survey and research; demand and resource-based industry-servicing industry - import substitution- Techno-economic feasibility assessment - shortlisting, preliminary project report, detailed project report, assessing viability and feasibility of a report.

Unit IV: Forms of Business Organisations/Ownership **6**

Forms of business organisations/ownership - formation of a Company - procedures and formalities for setting up of new industry sources of information to contact for what and where - subsidies and concessions for SSI - role of State and Central Government Agencies in promotion of Small-Scale Industry. Sickness and nursing of sickness in SSI.

Unit V: Labour Laws **6**

The Factories Act 1948, Minimum Wages Act - Payment of Wages 1936, Workmen Compensation Act, 1923.Taxation - State and Central - Concessions. Introduction to e-business; EDI and e-commerce; EDI standard, implementation and Tools; e-commerce imperatives, e-commerce applications: I - Markets, Customer care, Vendor Management and Extended supply chain management; security aspects - cryptography, digital signature, digital watermarking, secured socket layers, understanding threats to security, securing internet connections, Firewall techniques, electronic payment systems - ATM model, Payment Models, credit card based payment system, 1st virtual banking, e-cash, smart cards; Electronic Data interchange EDI) - Value added networks.

TEXTBOOK

1. D.F. Kuratko and R.M. Hodgetts, *Entrepreneurship: Theory, Process, and Practice*, 10th ed., Cengage Learning, 2013.
2. G. Trites, J. Burke, R. Byrd, C. Coe, and R. Gallupe, *E-Business: A Canadian Perspective*, 1st ed., Pearson Canada, 2002.
3. E. Ries, *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*, Currency, 2011.
4. A. Osterwalder and Y. Pigneur, *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*, 1st edition, Wiley, 2010.
5. D. Chaffey, *E-Business and E-Commerce Management*, 7th ed., Pearson, 2019.

REFERENCE BOOKS

1. P.F. Drucker, *Innovation and Entrepreneurship: Practice and Principles*, HarperBusiness, 2006.
2. G. Kawasaki, *The Art of Start 2.0: The Time-Tested, Battle-Hardened Guide for Anyone Starting Anything*, Portfolio, 2015.
3. S. Blank and B. Dorf, *The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company*, 2nd ed., Wiley.
4. A. Chaudhury and J.-P. Kuilboer, *E-Business and E-Commerce Infrastructure: Technologies Supporting the E-Business Initiative*, Pearson.
5. B. Aulet, *Disciplined Entrepreneurship: 24 Steps to a Successful Startup*, Wiley.
6. *Handbook for New Entrepreneurs*, EDII, Ahmedabad.
7. P. Saravanavel, *Entrepreneurial Development*.

Online Study Material

Websites:

- Coursera: Entrepreneurship and Business Strategy Courses
- edX: E-Business and Digital Marketing Courses
- Khan Academy: Entrepreneurship Basics
- Udacity: Digital Marketing and E-Business Courses

Video Resources:

- YouTube channels like "Stanford eCorner" and "TEDx Talks"
- Online platforms like Coursera, Udacity, and edX offer courses on entrepreneurship and e-business.

Case Studies and Resources:

- Harvard Business Review (HBR) articles on entrepreneurship and e-business.

- Access to case studies from successful startups and e-businesses.

Additional Resources:

- Participation in entrepreneurship events, workshops, and networking sessions.
- Exploration of successful e-business models and practices.
- Access to industry experts and guest lectures.

SEVENTH SEMESTER

AVAS471 (AV7MJ17): FINITE ELEMENT METHODS

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic understanding of structural mechanics and stress analysis.
- Proficiency in mathematics, including calculus and linear algebra.
- Familiarity with numerical methods and computer programming.
- Knowledge of engineering materials and their properties.

Course Objective

- Introduce the fundamental concepts and principles of finite element methods.
- Teach the mathematical foundation and formulation of finite element analysis.
- Explore the application of finite element methods in structural analysis.
- Enable students to use finite element software for simulations.

Course Outcome

- Understanding of the basic principles and history of finite element methods.
- Proficiency in formulating and solving engineering problems using finite element analysis.
- Capability to analyse and design structures under various loading conditions.
- Ability to apply finite element methods to real-world engineering challenges.
- Skills to interpret and validate finite element results. Focus on practical applications of finite element methods in engineering.

Unit I: Introduction **9**

Review of various approximate methods in structural analysis, stiffness and flexibility matrices for simple cases, basic concepts of finite element method, formulation of governing equations and convergence criteria.

Unit II: Discrete Elements **9**

Use of bar and beam elements in structural analysis. Computer implementation of procedure for these elements.

Unit III: Continuum Elements **9**

Different forms of 2D elements and their applications for plane stress, plane strain and axisymmetric problems. Consistent and lumped formulation. Use of local coordinates. Numerical integration.

Unit IV: ISO Parametric Elements **9**

Definition and use of different forms of 2D and 3D elements. Computer implementation of formulation of these elements for the analysis of typical structural parts.

Unit V: Solution Schemes **9**

Different methods of solution of simultaneous equations governing static, dynamic and stability problems. General purpose software packages.

TEXTBOOK

1. S. Moaveni, Finite Element Analysis: Theory and Application with ANSYS, 4th edition, Pearson, 2014.
2. T. R. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, 4th edition, Pearson, 2011.
3. J. Fish and T. Belytschko, *A First Course in Finite Elements*, 1st edition, Wiley, 2007.
4. D. S. Burnett, *Finite Element Analysis: From Concepts to Applications*, 1st edition, Addison Wesley, 1987.
5. D. V. Hutton, *Fundamentals of Finite Element Analysis*, 1st ed. McGraw Hill Education, 2017.

REFERENCE BOOKS

1. J. Segerlind, *Applied Finite Element Analysis*, 2nd ed. New York, NY: John Wiley and Sons Inc., 1984.
2. K. J. Bathe and E. L. Wilson, *Numerical Methods in Finite Element Analysis*. New Delhi, India: Prentice Hall of India Ltd., 1983.
3. R. D. Cook, *Concepts and Applications of Finite Element Analysis*, 3rd ed. New York, NY: John Wiley & Sons, 1989.
4. C. S. Krishnamurthy, *Finite Element Analysis*. New Delhi, India: Tata McGraw Hill, 1987.
5. V. Ramamurthi, *Computer Aided Design in Mechanical Engineering*. New Delhi, India: Tata McGraw Hill, 1987.

Online Study Material

Websites:

- Coursera: Finite Element Methods Courses
- edX: Finite Element Analysis and Simulation Courses
- MIT Open Course Ware: Finite Element Procedures
- NPTEL: Finite Element Analysis

Video Resources:

- YouTube channels like "NISE Courses" and "Cornell University School of Civil and Environmental Engineering"
- Online platforms like Coursera, Udacity, and edX offer courses on finite element methods.

Simulation Tools:

- ANSYS, Abaqus, or other finite element software for hands-on experience.
- Online platforms providing interactive finite element simulations.

Additional Resources:

- Access to research papers and case studies in the field of finite element analysis.
- Participation in finite element analysis competitions and workshops.
- Exploration of industry standards related to finite element methods.

FINITE ELEMENT METHODS LAB

List of Exercises **30**

1. Study of FEA package
2. Modeling and stress analysis of Trusses
3. Bars of constant cross-section area, tapered cross-section area and stepped bars
4. Beams: Cantilever, simply supported, overhanging beams with self-weight, Concentrated loads, UDL, Direct moment and UVL with different support conditions.
5. Stress analysis of a rectangular plate with a circular hole, Stress analysis of Axisymmetric problems – Pressurized cylinder and rotating disc or cylinders (Solid and hollow).
6. Dynamic Analysis: Modal analysis of Bars and Beams. Dynamic Analysis: Harmonic analysis of Bar subjected to forcing function and Fixed-Fixed beam subjected to forcing function.
7. Thermal Analysis – 1D problems with conduction and convection boundary conditions. Thermal Analysis – 2D problems with conduction and convection boundary conditions.
8. Fluid flow Analysis – Potential distribution in 2-D bodies.

AVAS472 (AV7MJ18): EMBEDDED SYSTEM DESIGN

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic understanding of computer architecture and microprocessor systems.
- Proficiency in programming languages, particularly C and/or Assembly.
- Familiarity with digital electronics and logic design.
- Knowledge of operating systems and real-time systems concepts.

Course Objective

- Introduce the fundamental concepts and principles of embedded systems.
- Teach the design and development of embedded systems using microcontrollers/ microprocessors.
- Explore interfacing of peripherals and sensors with embedded systems.
- Enable students to program and debug embedded systems.
- Focus on practical applications of embedded systems in various domains.

Course Outcome

- Understanding of the basic principles and history of embedded systems.
- Proficiency in designing and programming embedded systems.
- Capability to interface peripherals and sensors with embedded systems.
- Ability to analyse and optimize the performance of embedded systems.
- Skills to apply theoretical concepts to real-world embedded system design challenges.

Unit I: Introduction to Embedded System **9**

Introduction to functional building blocks of embedded systems – Register, memory devices, ports, timer, and interrupt controllers using circuit block diagram representation for each category.

Unit II: Processor and Memory Organization **9**

Structural units in a processor; selection of processor & memory devices; shared memory; DMA; interfacing processor, memory and I/O units; memory management – Cache mapping techniques, dynamic allocation - Fragmentation.

Unit III: Devices & Buses for Devices Network **9**

I/O devices; timer & counting devices; serial communication using I2C, CAN, USB buses; parallel communication using ISA, PCI, PCI/X buses, arm bus; interfacing with devices/ports, device drivers in a system – Serial port & parallel port.

Unit IV: I/O Programming Schedule Mechanism **9**

Intel I/O instruction – Transfer rate, latency; interrupt driven I/O - Non-maskable interrupts; software interrupts, writing interrupt service routine in C & assembly languages; preventing interrupt overrun; disability interrupts. Multi-threaded programming – Context switching,

premature & non-premature multitasking, semaphores. Scheduling – Thread states, pending threads, context switching, round robin scheduling, priority-based scheduling, assigning priorities, deadlock, watchdog timers.

Unit V: Real-Time Operating System (RTOS) 9

Introduction to basic concepts of RTOS, Basics of real-time & embedded system operating systems, RTOS – Interrupt handling, task scheduling; embedded system design issues in the system development process – Action plan, use of target system, emulator, use of software tools.

TEXTBOOK

1. R. Kamal, *Embedded System – Architecture, Programming, Design*, 3rd edition, New Delhi, India: Tata McGraw Hill, 2017.
2. D. W. Lewis, *Fundamentals of Embedded Software*, New Delhi, India: Prentice Hall of India, 2004.
3. A. S. Berger, *Embedded Systems Design: An Introduction to Processes, Tools, and Techniques*. 1st edition, McGraw Hill, 2001.
4. J. W. Valvano, *Embedded Systems: Introduction to ARM Cortex-M Microcontrollers*, 5th edition, 2013.

REFERENCE BOOKS

1. D. E. Simon, *An Embedded Software Primer*, 1st edition, Upper Saddle River, NJ: Pearson Education, 2004.
2. F. Vahid, *Embedded System Design – A Unified Hardware & Software Introduction*, 1st ed. Hoboken, NJ: John Wiley & Sons, 2002.
3. S. V. Iyer and P. Gupte, *Embedded Real-Time Systems Programming*, 1st ed. New Delhi, India: Tata McGraw Hill, 2004.
4. S. Heath, *Embedded System Design*, 2nd ed. Oxford, UK: Elsevier, 2003.
5. R. Kamal, *Embedded Systems: Design and Applications with the 8051 Microcontroller*, 2nd ed. New Delhi, India: Tata McGraw Hill, 2008.

Online Study Material

Websites:

- Embedded Systems - NPTEL
- Embedded Systems - Coursera
- ARM University Program
- Embedded Systems - edX

Video Resources:

- YouTube channels like "The Embedded Rust Working Group" and "Dave Astels"
- Online platforms like Coursera, Udacity, and edX offer courses on embedded systems.

Simulation and Development Tools:

- Keil, MPLAB, or other embedded development tools.
- Online platforms providing interactive simulations for embedded systems.

Additional Resources:

- Access to microcontroller/microprocessor datasheets and technical documentation.
- Participation in embedded system design projects and competitions.
- Exploration of industry standards and practices related to embedded systems.

EMBEDDED SYSTEM DESIGN LAB

Program Objective

- IDE for Embedded System Design using MSP430;
- Interfacing Switch & LED;
- Timers-WDT, Configuring, Programming;
- ADC-usage; Power down modes; DAC; PWM Generator;
- Networking - SPI, Wi-Fi.

Program Outcome

- On successful completion of the course, students will be able to
- Demonstrate knowledge in designing complex energy-efficient embedded systems.
- Analyse usage of various on-chip resources like GPIO, Timers, Interrupts, ADC, DAC, Comparator, and SPI.
- Solve engineering problems by proposing potential solutions using industry-choice advanced Microcontrollers.

List of Exercises **30**

1. Introduction to the MSP430 launch pad and Programming Environment. (Study Experiment)
2. Read input from the switch and Automatic control/flash LED (software delay).
3. Interrupts programming example using GPIO.
4. Configure the watchdog timer in watchdog mode & interval mode.
5. Configure timer block for signal generation (with given frequency)
6. Read the Temperature of MSP430 with the help of ADC.
7. Test various Power Down modes in MSP430.
8. PWM Generator
9. Use Comparator to compare the signal threshold level
10. Speed Control of DC Motor
11. Master-slave communication between MSPs using SPI
12. Networking MSPs using Wi-Fi
13. Code Composer Studio Version 6, MSP430-based launch pads, Wi-Fi booster pack.

REFERENCE BOOKS

1. J. H. Davies, *MSP430 Microcontrollers Basics*, 1st ed. Oxford, UK: Newnes Publishers, 2008.
2. C. P. Ravikumar, *MSP430 Microcontrollers in Embedded System Projects*, 1st ed. Bangalore, India: Elite Publishing House, 2012.

AVAS473 (AV7MJ19): FLIGHT CONTROL SYSTEM DESIGN

L	T	P	C	45L
3	1	0	4	

Prerequisites

- Background in aerospace engineering or related field.
- Understanding of aircraft dynamics and aerodynamics.
- Knowledge of control systems and stability analysis.
- Familiarity with mathematical modeling and simulation.
- Proficiency in programming and numerical analysis.

Course Objective

- Introduce the fundamental concepts and principles of flight control systems.
- Teach the design and analysis of control systems for aircraft.
- Explore the modelling and simulation of aircraft dynamics.
- Enable students to understand stability and control challenges in aviation.
- Focus on practical applications of flight control systems in aviation.

Course Outcome

- Understanding of the basic principles and history of flight control systems.
- Proficiency in designing and analysing control systems for aircraft.
- Capability to model and simulate aircraft dynamics for control system design.
- Ability to analyse and optimize the stability and control of aircraft.
- Skills to apply theoretical concepts to real-world flight control challenges.
- architect the control system of flying vehicles and preliminary design flight control systems.

Unit I: Introduction to Control System Design **9**

Introduction to Control System Design, Open vs. Closed Loop Control, Analogue, Digital and Logical Control, Industrial Controllers, Control System Design Objectives, Control System Design Cycle. Introduction to Flight Control Systems, History, Guidance, Navigation and Control, Flight Control Channels, Flight Control Methods, SAS vs. Autopilot.

Unit II: Aerodynamic Considerations of Flight Control Systems **9**

Aerodynamic Considerations of Flight Control Systems, Static and Dynamic Stability, Stability and Maneuverability, Static Margin, Variations of the Center of Pressure, Hinge Moment, Aeroelastic Effects. Control System Performance, Canard Control, Wing Control, Tail Control, Fin Configuration Effects, Side Jet Control, Thrust Vector Control, Variation of Mass and CG.

Unit III: Flight Control Actuators **9**

Servomechanism, Reversible vs. Irreversible mechanisms, Hydraulic Actuators, Pneumatic Actuators, Electric Actuators. Flight Control Sensors: Accelerometers, Gyroscopes, Angle of attack vane, Other sensors, Sensor Selection. An Overview of Controller Design: Objectives, Design Using Frequency Response, Design Using Root Locus, Pole Placement Methods.

Unit IV: Linearization and Transfer Functions of Flying Vehicles **9**

Coordinate Systems, Equations of Motion, Roll, Pitch and Yaw Transfer Functions. Design of Aerodynamic Control System for Missiles: STT vs. BTT, Lateral Control System Design for STT, Roll Control, Control System Design for BTT, MIMO Based Design, Design of Single Channel Flight Control Systems.

Unit V: Aircraft Control System Design **9**

Longitudinal Control, Lateral Control, Attitude Control Systems, Flight Path Control Systems, Active Control Systems. Thrust Vector Control: Classifications and Applications, Mathematical Modelling, Control Architectures, Controller Design. Miscellaneous Topics: Sensitivity Analysis, Man in the Loop considerations, Parameter Optimization.

TEXTBOOK

1. P. Garnell, *Guided Weapon Control Systems*, 2nd ed. Oxford, UK: Pergamon Press, 1980.
2. D. McLean, *Automatic Flight Control Systems*. London, UK: Prentice Hall International (UK) Ltd, 1990.
3. J. H. Blakelock, *Automatic Control of Aircraft and Missiles*, 2nd ed. Hoboken, NJ: John Wiley & Sons, 1990.
4. R. Vepa, *Flight Dynamics, Simulation, and Control: For Rigid and Flexible Aircraft*. 1st edition, CRC Press Inc., 2014.
5. B. L. Stevens, F. L. Lewis, and E. N. Johnson, *Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems*. 3rd edition, Hoboken, NJ: John Wiley & Sons, Inc., 2016.

REFERENCE BOOKS

1. M. R. Napolitano, *Aircraft Dynamics: From Modeling to Simulation*, 1st ed. Hoboken, NJ: John Wiley & Sons, Inc., 2011.
2. B. L. Stevens, F. L. Lewis, and E. N. Johnson, *Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems*. 3rd edition, Hoboken, NJ: John Wiley & Sons, Inc., 2016.
3. D. Allerton, *Principles of Flight Simulation*, 1st ed. Chichester, UK: John Wiley & Sons, Ltd., 2009.

Online Study Material

Websites:

- MIT OpenCourseWare: Aircraft Systems Engineering
- Khan Academy: Control Systems Engineering
- Coursera: Aircraft Dynamics and Control Courses
- edX: Aerospace Engineering Courses

Video Resources:

- YouTube channels like "Control Systems Lectures" and "Aerospace Engineering and Aviation"
- Online platforms like Coursera, Udacity, and edX offer courses on flight control systems.

Simulation Tools:

- MATLAB/Simulink or other simulation tools for aircraft dynamics.
- Online platforms providing interactive simulations for flight control systems.

Additional Resources:

- Access to research papers and case studies in the field of flight control systems.
- Participation in aerospace engineering conferences and workshops.
- Collaboration with professionals in the aviation industry.

AVAS474 (AV7MJ20): ELECTRONICS SENSORS AND INSTRUMENTATION FOR AVS

L	T	P	C	45L
3	0	2	4	

Prerequisites: NIL

Course Objective

- To understand the purpose of measurement, the methods of measurements, errors associated with measurements.
- To know the principle of transduction and classifications of sensors used in healthcare applications.
- To describe the characteristics of different sensors used in healthcare applications.
- To summarize the different types of chemical and biosensors.
- To know the different display and recording devices.

Course Outcome

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

- Illustrate the various characteristics of sensors and measurement systems.
- Select appropriate passive or active transducers for measurement of displacement, temperature and pressure.
- Evaluate the use of photoelectric and piezoelectric sensors for biomedical applications.
- Use the chemical and biosensors for measuring glucose and urea.
- Assess AC and DC bridges and recorders for appropriate measurement.

Unit I: Science of Measurement **9**

Measurement System – Instrumentation - Classification and Characteristics of Transducers - Static and Dynamic - Errors in Measurements and their Statistical Analysis – Calibration - Primary and Secondary Standards.

Unit II: Sensors **9**

Displacement, pressure, temperature sensors; Strain Gauge: Gauge factor, sensing elements, configuration, and unbounded strain gauge. Capacitive transducer -various arrangements, Inductive transducer, LVDT, Passive types: RTD materials & range, relative resistance vs. temperature characteristics, thermistor characteristics, Thermocouple - characteristics.

Unit III: Photoelectric and Piezo Electric Sensors **9**

Phototube, scintillation counter, photomultiplier tube (PMT), photovoltaic, photoconductive cells, photodiodes, phototransistor, comparison of photoelectric transducers. Spectrophotometric applications of photoelectric transducers. Piezoelectric active transducer - Equivalent circuit and its characteristics, pressure & ultrasound transducer.

Unit IV: Measurements and Recording Devices 9

AC and DC Bridges -Wheat stone bridge, Kelvin's double bridge, Maxwell's bridge, Hay's bridge, Schering's bridge. PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermal recorder.

Unit V: Signal Conditioning and DAQ Systems **9**

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

TEXTBOOK

1. J. G. Webster, *Medical Instrumentation Application and Design*, 5th edition, Wiley India Pvt. Ltd,New Delhi, 2020
2. A. K. Sawhney, Electrical & Electronics Measurement and Instrumentation, 19th Revised edition, Dhanpat Rai & Co, New Delhi, Reprint 2015.
3. E. O. Doebelin and D. N. Manik, *Measurement systems, Application and design*, 6th edition, McGraw Hill, 2012.

REFERENCE BOOKS

1. A. Geddes and L. E. Baker, *Principles of Applied Biomedical Instrumentation*, 3rd ed. New Delhi, India: Wiley India Pvt. Ltd, 2008.
2. R. S. Khandpur, *Handbook of Biomedical Instrumentation*, 3rd ed. New Delhi, India: Tata McGraw Hill, 2014.
3. L. Cromwell, *Biomedical Instrumentation and Measurement*, 2nd ed. New Delhi, India: Prentice Hall of India, 2015.
4. A. D. Helfrick and W. D. Cooper, *Modern Electronic Instrumentation and Measurement Techniques*, 1st ed. New Delhi, India: Prentice Hall of India, 2016.

SENSORS AND INSTRUMENTATION LAB

Program Outcome

On completion of the course, students will be able to

- Understand the functioning of a few sensors and transducers
- Understand the characteristics of a few sensors and transducers
- Understand the process and need for calibration.
- Calibrate voltmeters and ammeters.
- Choose the sensor for the measurement of a few parameters.
- Use the appropriate sensor and calibrate

List of Exercises **30**

1. Study of Sensors and Measuring Instruments
2. Measurement of Strain Using Strain Gauge
3. Study of Distance Measurement Using Ultrasonic Transducer
4. To Determine Output Characteristics of LVDT And Measure Displacement Using LVDT
5. Flow Measurement and Level Detection.
6. Measurement of Inductance, Resistance and Capacitance.
7. Voltage and Current detection
8. Temperature Measurement using Thermocouple
9. Resistance Measurement using Potentiometer
10. SONAR

AVAS475 (AV7MI19): MAINTENANCE OF AVS

L	T	P	C	45L
3	1	0	4	

Prerequisites: NIL

Course Objective

- Understand Aircraft Systems and Components
- Learn Maintenance Regulations and Procedures
- Develop Technical Skills in Airframe Maintenance
- Gain Proficiency in System Maintenance
- Ensure Safety and Compliance

Course Outcome

1. Understanding of Aircraft Structures and Materials
2. Knowledge of Airframe Inspection and Maintenance Procedures
3. Proficiency in Aircraft Rigging and Alignment
4. Competence in Sheet Metal Fabrication and Repair
5. Understanding of Aircraft Systems

Unit I: Airframe Structure & Controls **9**

Various types of structures in airframe construction, tubular, braced monocoque, semi-moncoque, etc. Longerons, stringers, formers, bulkhead, spars and ribs, honeycomb construction. Airplane controls, ailerons, elevators, rudder, trimming and control tabs, leading and trailing edge flaps, tail plane and fins.

Unit II: Aircraft Structure Associated Materials **9**

Basics of structure and structural components fabricated from metal, glass fiber, vinyl, Perspex, composites. Finishing materials, paints, surface finishes and associated materials.

Unit III: Aircraft Control Systems & Auxiliary Systems **9**

Flying controls including power-operated controls, hydraulic, pneumatic, landing gear various types, shock struts, nose wheel steering. Oxygen, air-conditioning and pressurization systems, wheels, tyres brakes, antiskid system. Ice and rain protection, fire detection warning and extinguishing, Windows, doors and emergency exists. Reliability and redundancy of systems design.

Unit IV: Basic Inspections **9**

Basic principles of inspection, gauges, and tools. Standard inspection techniques and procedures. Go/No go gauges, gauge calibration and maintenance, limits and tolerance. NDT techniques.

Unit V: Major Inspections **9**

Major and minor damage, damage tolerance. Corrosion and corrosion prevention. Major and minor defects. Defect reporting rectification and investigation. Rigging of aircraft, symmetry checks. Balancing of control surfaces.

Periodical inspections: Periodical inspections, heavy landing, overweight landing checks, abnormal flight loads. Aircraft weighing, weight schedule, and calculation of the centre of gravity. Electrostatic Sensitive Devices, Electromagnetic Environment.

TEXTBOOK

1. K. W. Watkins, and F. Delp, *Aircraft Maintenance and Repair*. New York, NY: McGraw-Hill, 2013.
2. Federal Aviation Administration (FAA), *Aviation Maintenance Technician Handbook – General*. Oklahoma City, OK: Skyhorse Publishing, 2018.
3. D. DeRemer, *Aircraft Systems for Pilots*. New York, NY: McGraw-Hill, 1994.
4. J. J. Huss, *Introduction to Aircraft Maintenance*. New York, NY: Wiley, 2003.
5. J. S. Hamilton, *Practical Aviation & Aerospace Law*. Newcastle, WA: Aviation Supplies & Academics, 2018.

REFERENCE BOOKS

1. G. Titterton, *Aircraft Materials and Processes*. New York, NY: Macmillan, 1973.
2. L. Reithmaier, *Standard Aircraft Handbook for Mechanics and Technicians*. New York, NY: McGraw-Hill, 2009.
3. T. K. Eismin, *Aircraft Electricity and Electronics*. New York, NY: McGraw-Hill, 2007.
4. E. W. Hinchliffe, *Aircraft Hydraulic Systems: An Introduction to the Analysis of Systems and Components. Malabar*, FL: Krieger Publishing Company, 1999.
5. E. H. J. Pallett, *Aircraft Instruments and Integrated Systems*. Harlow, UK: Pearson Education, 2003.

Online Study Material

1. FAA's Aircraft Maintenance Technician Handbooks.
2. Aviation Maintenance Technician (AMT) Training Programs.
3. Aircraft Manufacturer Websites.

ASAV475 (AV7MI20): BLOCKCHAIN TECHNOLOGY

L	T	P	C	45L
3	1	0	4	

Prerequisites

- Basic understanding of computer science and programming.
- Knowledge of cryptography fundamentals.
- Familiarity with distributed systems and databases.
- Proficiency in data structures and algorithms.
- Understanding of networking and cybersecurity concepts.

Course Objective

- Introduce the fundamental concepts and principles of blockchain technology.
- Teach the design, architecture, and implementation of blockchain systems.
- Explore smart contracts, consensus mechanisms, and decentralized applications (dApps).
- Enable students to analyse blockchain use cases in various industries.
- Focus on practical applications and real-world implications of blockchain.

Course Outcome

- Understanding of the basic principles and history of blockchain technology.
- Proficiency in designing and developing blockchain-based solutions.
- Capability to analyse and evaluate blockchain applications in different sectors.
- Ability to identify and address security and scalability challenges in blockchain.
- Skills to contribute to the innovation and advancement of blockchain technology.

Unit I: Introduction to Blockchain **9**

Need for Distributed Record Keeping, Modeling faults and adversaries, Byzantine Generals problem, Consensus algorithms and their scalability problems, Nakamoto's concept with Blockchain-based cryptocurrency, Technologies Borrowed in Blockchain – hash pointers, consensus, byzantine fault-tolerant distributed computing, digital cash etc.

Unit II: Basic Distributed Computing & Crypto primitives **9**

Atomic Broadcast, Consensus, Byzantine Models of fault tolerance, Hash functions, Puzzle friendly Hash, Collison resistant hash, digital signatures, public key crypto, verifiable random functions, Zero-knowledge systems.

Unit III: Bitcoin Basics **9**

Bitcoin blockchain, Challenges and solutions, proof of work, Proof of stake, alternatives to Bitcoin consensus, Bitcoin scripting language and their use.

Unit IV: Ethereum Basics **9**

Ethereum and Smart Contracts, The Turing Completeness of Smart Contract Languages and verification challenges, Using smart contracts to enforce legal contracts, comparing Bitcoin scripting vs. Ethereum Smart Contracts, Writing smart contracts using Solidity & JavaScript.

Unit V: Privacy, Security Issues in Blockchain **9**

Pseudo-anonymity vs. anonymity, Zcash and Zk-SNARKS for anonymity preservation, attacks on Blockchains: Sybil attacks, selfish mining, 51% attacks advent of Legoland; Sharding based consensus algorithms to prevent these attacks. Case Studies: Blockchain in Financial Service, Supply Chain Management and Government Services.

TEXTBOOK

1. A. M. Antonopoulos, *Mastering Bitcoin: Unlocking Digital Cryptocurrencies*, 2nd ed. Sebastopol, CA: O'Reilly Media, 2017.
2. D. Drescher, *Blockchain Basics: A Non-Technical Introduction in 25 Steps*. Berkeley, CA: Apress, 2017.
3. H. Diedrich, Ethereum: Blockchains, *Digital Assets, Smart Contracts, Decentralized Autonomous Organizations*. Berkeley, CA: Apress, 2018.
4. N. Prusty, *Building Blockchain Projects*. Birmingham, UK: Packt Publishing, 2017.

REFERENCE BOOKS

1. Narayanan, J. Bonneau, E. Felten, A. Miller, and S. Goldfeder, *Bitcoin and Cryptocurrency Technologies – A Comprehensive Introduction*. Princeton, NJ: Princeton University Press, 2016.
2. J. Thompson, *Blockchain: The Blockchain for Beginners, Guide to Blockchain Technology and Blockchain Programming*. CreateSpace Independent Publishing Platform, 2017.
3. I. Bashir, *Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained*. 2nd edition, Birmingham, UK: Packt Publishing, 2018.
4. M. Grincalaitis, *Mastering Ethereum: Implement Advanced Blockchain Applications Using Ethereum-supported Tools, Services, and Protocols*. 1st edition, Birmingham, UK: Packt Publishing, 2019.

Online Study Material

Websites:

- Coursera: Blockchain Specializations and Courses
- edX: Blockchain Fundamentals and Applications Courses
- Hyperledger Documentation
- Ethereum Documentation and Solidity Tutorials

Video Resources:

- YouTube channels like "Ivan on Tech" and "CryptoCandor"
- Online platforms like Coursera, Udacity, and edX offer courses on blockchain technology.

NPTEL:

- https://nptel.ac.in/courses/106/105/106105184/

Development Platforms:

- Ethereum Remix IDE or Truffle Suite for smart contract development.
- Hyperledger Composer Playground for Hyperledger-based projects.

Additional Resources:

- Participation in blockchain hackathons and workshops.
- Access to whitepapers and research articles in blockchain technology.
- Collaboration with blockchain developers and industry experts.

AVAS475 (AV7MI21): CRYPTOGRAPHY AND NETWORK SECURITY

L	T	P	C	45L
3	1	0	4	

Prerequisites: NIL

Course Objective

- Fundamental Concepts**,** Cryptography Algorithms**,** Security Protocols**,** Cryptanalysis Techniques**.**
- Key Management**,** Public Key Infrastructure (PKI)**:** Introduce students to the concept of PKI and its components, including digital certificates, certificate authorities (CAs), registration authorities (RAs), and certificate revocation lists (CRLs).
- Secure Communication**:** Enable students to design and implement secure communication protocols and mechanisms to protect data transmission over insecure networks, including message authentication codes (MACs) and digital signatures.
- Network Security Architecture**:** Examine network security architectures, including firewalls, intrusion detection systems (IDS), intrusion prevention systems (IPS), and network access control (NAC), and their role in defending against cyber threats.

Course Outcome

- Understanding of Cryptographic Principles
- Knowledge of Network Security Technologies
- Ability to Analyse Security Risks and Threats
- Skill in Cryptographic Implementation
- Understanding of Public Key Infrastructure
- Awareness of Regulatory Compliance and Standards

Unit I: Computer Network Fundamentals **9**

Computer Network Fundamentals - Introduction - Computer Network Models Computer Network Types - Data Communication Media Technology - Network Topology Network Connectivity and Protocol - Network Services - Network Connecting Devices- Network Technologies

Unit II: Network Security **9**

Understanding Network Security - Defining Network Security - Security Services - Security Standards - Elements of Security - Security Threats to Computer Networks Sources of Security Threats - Security Threat Motives - Security Threat Management-Security Threat Correlation.

Unit III: Computer Network Vulnerabilities **9**

Computer Network Vulnerabilities - Sources of Vulnerabilities- Vulnerability Assessment - Cyber Crimes and Hackers - Cyber Crimes – Hacker - Dealing with the Rising Tide of Cyber Crimes

Unit IV: Dealing with Network Security Challenges **9**

Dealing with Network Security Challenges - Access Rights - Access Control Systems – Authorization - Types of Authorization Systems – Authentication - Multiple Factors and

Effectiveness of Authentication - Authentication Elements Types of Authentications - Authentication Methods Developing an Authentication Policy

Unit V: Cryptography **9**

Definition - Block Ciphers - Symmetric Encryption - Public Key Encryption - Key Management: Generation, Transportation, and Distribution - Public Key Infrastructure (PKI) - Hash Function - Digital Signatures – Firewalls - Types of Firewalls - Configuration and Implementation of a Firewall - Firewall Forensics - Firewall Services and Limitations - Computer Network Security Protocols and Standards - Application-Level Security -Security in the Transport Layer Security in the Network Layer

TEXTBOOK

1. S. Kizza and J. Migga, *Computer Network Security*. Berlin, Germany: Springer, 2005.
2. W. Stallings, *Cryptography & Network Security*, 4th ed. Upper Saddle River, NJ: Pearson Education, 2010.
3. W. Stallings, *Cryptography and Network Security: Principles and Practice*. Upper 7th edition, Saddle River, NJ: Pearson, 2017.
4. J. Katz and Y. Lindell, *Introduction to Modern Cryptography*. 2nd edition, Boca Raton, FL: CRC Press, 2014.
5. M. E. Whitman and H. J. Mattord, *Principles of Information Security*. 6th edition, Boston, MA: Cengage Learning, 2017.

REFERENCE BOOKS

1. N. Ferguson, B. Schneier, and T. Kohno, *Cryptography Engineering: Design Principles and Practical Applications*. 1st edition, Hoboken, NJ: Wiley, 2010.
2. W. Stallings and L. Brown, *Computer Security: Principles and Practice*. 3rd edition, Upper Saddle River, NJ: Pearson, 2013.
3. C. Kaufman, R. Perlman, and M. Speciner, *Network Security: Private Communication in a Public World*. 2nd edition, Upper Saddle River, NJ: Pearson, 2002.
4. R. J. Anderson, *Security Engineering: A Guide to Building Dependable Distributed Systems*. 2nd edition, Hoboken, NJ: Wiley, 2008.
5. C. Paar and J. Pelzl, *Understanding Cryptography: A Textbook for Students and Practitioners*. Berlin, Germany: Springer, 2014.

Online Study Material

Coursera:

- Cryptography and Network Security courses offered by universities such as Stanford University, University of Maryland, and Eindhoven University of Technology.

edX:

- Cryptography courses offered by institutions like MIT, UC Berkeley, and the University of Maryland.

Cybrary:

- Free online courses and resources on cryptography, network security, and ethical hacking.

YouTube Channels:

- Cryptography and network security tutorials and lectures from channels like Computerphile, MIT OpenCourseWare, and Khan Academy.

NIST Computer Security Resource Center (CSRC):

- Publications, guidelines, and research papers on cryptography and network security from the National Institute of Standards and Technology (NIST).

GitHub Repositories:

- Open-source cryptography libraries, tools, and projects for hands-on learning and experimentation.

AVAS476 (AV7MI22): ADVANCED MATERIALS AND MANUFACTURING FOR AVS

L	T	P	C	45L
3	1	0	4	

Prerequisites

- Background in materials science and engineering.
- Understanding of basic principles of chemistry and physics.
- Proficiency in materials characterization techniques.
- Familiarity with engineering materials and their properties.
- Knowledge of manufacturing processes and material behaviour.

Course Objective

- Introduce advanced materials and their applications in engineering.
- Explore the synthesis, processing, and properties of advanced materials.
- Teach the principles of nanomaterials, biomaterials, and smart materials.
- Enable students to understand the behaviour of materials under extreme conditions.
- Focus on practical applications of advanced materials in various industries.

Course Outcome

- Understanding of the basic principles and history of advanced materials.
- Proficiency in analysing and designing with advanced materials.
- Capability to evaluate the properties and performance of advanced materials.
- Ability to apply advanced materials to solve complex engineering problems.
- Skills to contribute to the development and innovation of advanced materials.

Unit I: Introduction to Composite Materials **9**

Introduction, classification: polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon-carbon composites, Fiber reinforced composites and nature-made composites, and applications. REINFORCEMENTS: Fibres- glass, silica, kevlar, carbon, boron, silicon carbide, and boron carbide fibres.

Unit II: Polymer Composites and Plastics **9**

Polymer composites, thermoplastics, thermosetting plastics, manufacturing of PMC, MMC & CCC and their applications.

Unit III: Manufacturing Methods **9**

Autoclave, tape production, moulding methods, filament winding, hand layup, pultrusion, RTM.

Unit IV: Macro-mechanical Analysis of a Lamina **9**

Introduction, generalised Hooke's law, reduction of Hooke's law in three dimensions to two dimensions, relationship of compliance and stiffness matrix to engineering elastic constants of an orthotropic lamina, laminate-laminate code.

Unit V: Functionally Graded Materials **9**

Types of functionally graded materials-classification different systems-preparation-properties and applications of functionally graded materials. Shape memory alloys: Introduction-shape

memory effect-classification of shape memory alloys composition-properties and applications of shape memory alloys. Nanomaterials: Introduction-properties at nano scales-advantages & disadvantages-applications in comparison with bulk materials (nanostructure, wires, tubes, composites). State-of-the-art nano advanced- topic delivered by the student.

TEXTBOOK

1. K. Bandyopadhyay, *Nano Materials*. Kolkata, India: New Age Publishers, 2010.
2. R. W. Cahn, *Material Science and Technology: A Comprehensive Treatment*. Weinheim, Germany: VCH, 2005.
3. I. Isaac and M. Daniel, *Engineering Mechanics of Composite Materials*. Oxford, UK: Oxford University Press, 1995.
4. W. D. Callister Jr. and D. G. Rethwisch, *Materials Science and Engineering: An Introduction*, 10th ed. Hoboken, NJ: Wiley, 2018.
5. K. G. Budinski and M. K. Budinski, *Introduction to Materials Science and Engineering*, 8th ed. Hoboken, NJ: Wiley, 2004.

REFERENCE BOOKS

1. R. M. Jones, *Mechanics of Composite Materials*. New York, NY: McGraw Hill, 1975.
2. L. R. Calcote, *Analysis of Laminated Composite Structures*. New York, NY: Van Nostrand Reinhold, 1969.
3. B. D. Agarwal and L. J. Broutman, *Analysis and Performance of Fiber Composites*. New York, NY: Wiley-Interscience, 1980.
4. A. K. Kaw, *Mechanics of Composite Materials*, 2nd ed. Boca Raton, FL: CRC Press, 2005.
5. C. Gilmore, *Materials Science and Engineering: Properties*, 1st ed. Hoboken, NJ: Wiley, 2016.

Online Study Material

Websites:

- Coursera: Materials Science and Engineering Courses
- edX: Advanced Materials and Nanotechnology Courses
- MIT OpenCourseWare: Introduction to Materials Science and Engineering
- NPTEL: Advanced Materials

Video Resources:

- YouTube channels like "MIT OpenCourseWare" and "Materials Science and Engineering with Dr. Michael S. Mamlouk"
- Online platforms like Coursera, Udacity, and edX offer courses on advanced materials.

AVAS476 (AV7MI23): DIGITAL IMAGE PROCESSING FOR AVS

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Basic understanding of signals and systems.
- Knowledge of linear algebra and calculus.
- Familiarity with basic programming concepts.
- Understanding of computer architecture and data structures.

Course Objective

- Introduce the fundamental concepts and techniques of digital image processing.
- Teach the principles of image enhancement, transformation, and compression.
- Explore image segmentation, feature extraction, and pattern recognition.
- Enable students to apply digital image processing techniques to real-world problems.
- Focus on practical applications in various fields such as computer vision and medical imaging.

Course Outcome

- Understanding of the basic principles and history of digital image processing.
- Proficiency in implementing image processing algorithms using software tools.
- Capability to analyse and enhance images for various applications.
- Ability to apply image processing techniques to solve complex problems.
- Skills to design and implement image processing solutions in different domains.

Unit I: Digital Image Fundamentals **9**

Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels - Color image fundamentals - RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT.

Unit II: Image Enhancement **9**

Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.

Unit III: Image Restoration **9**

Image Restoration - degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering

Unit IV: Image Segmentation **9**

Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm.

Unit V: Image Compression and Recognition **9**

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching.

TEXTBOOK

1. R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, 3rd ed. Boston, MA: Pearson, 2010.
2. A. K. Jain, *Fundamentals of Digital Image Processing*. Upper Saddle River, NJ: Pearson, 2002.
3. R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, 4th ed. Hoboken, NJ: Pearson, 2018.
4. R. C. Gonzalez, R. E. Woods, and S. L. Eddins, *Digital Image Processing Using MATLAB*. 2nd ed. Boston, MA: Pearson, 2009.
5. M. Sonka, V. Hlavac, and R. Boyle, *Image Processing, Analysis, and Machine Vision*, 4th ed. Boston, MA: Cengage Learning, 2014.

REFERENCE BOOKS

1. K. R. Castleman, *Digital Image Processing*. Boston, MA: Pearson, 2006.
2. R. C. Gonzalez, R. E. Woods, and S. L. Eddins, *Digital Image Processing using MATLAB*. Boston, MA: Pearson Education, Inc., 2011.
3. D. E. Dudgeon and R. M. Mersereau, *Multidimensional Digital Signal Processing*. Upper Saddle River, NJ: Prentice Hall Professional Technical Reference, 1990.
4. W. K. Pratt, *Digital Image Processing*. New York, NY: John Wiley & Sons, 2002.
5. M. Sonka, V. Hlavac, and R. Boyle, *Image Processing, Analysis, and Machine Vision*, 2nd ed. Pacific Grove, CA: Brooks/Cole, 1999.
6. L. G. Shapiro and G. C. Stockman, *Introduction to Computer Vision*. Upper Saddle River, NJ: Prentice Hall, 2001.

Online Study Material

Websites:

- Coursera: Digital Image Processing Courses
- edX: Image and Video Processing Courses
- NPTEL: Digital Image Processing
- Khan Academy: Image Processing Basics

Video Resources:

- YouTube channels like "Digital Image Processing Lectures" and "Computerphile"
- Online platforms like Coursera, Udacity, and edX offer courses on digital image processing.

Software Tools:

- MATLAB or Python with libraries like OpenCV for hands-on implementation.
- Online platforms providing interactive image processing simulations.

Additional Resources:

- Access to image processing datasets for practical projects.
- Participation in image processing competitions and hackathons.
- Exploration of recent research papers and trends in digital image processing.

AVAS476 (AV7MI24): ARTIFICIAL NEURAL NETWORKS FOR AVS

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Understanding of basic mathematics: calculus, linear algebra, and probability theory.
- Proficiency in programming, preferably in Python or R.
- Familiarity with data structures and algorithms.
- Basic knowledge of statistics and data analysis.

Course Objective

The primary objective of a course in Artificial Neural Networks for Autonomous Vehicles is to provide students with the knowledge and skills necessary to understand, design, and implement neural network algorithms and architectures for various tasks in autonomous vehicle systems. The course aims to familiarize students with the theoretical foundations, practical applications, and emerging trends in artificial intelligence (AI) and machine learning (ML) for AVS.

Course Outcome

- Understanding of Neural Network Principles
- Proficiency in Neural Network Design
- Knowledge of AV Sensors and Data Fusion
- Skill in Machine Learning Frameworks
- Ability to Evaluate and Optimize Neural Networks
- Awareness of Safety and Reliability Considerations

Unit I: Introduction to Neural Network **9**

A Neural Network, Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks. Learning Process: Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning, Credit Assignment Problem, Memory, Adaption, Statistical Nature of the Learning Process

Unit II: Single Layer Perceptrons **9**

Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron –Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment Multilayer Perceptron: Back Propagation Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection.

Unit III: Back Propagation **9**

Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning.

Unit IV: Self-Organization Maps (SOM) **9**

Two Basic Feature Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Patter Classification.

Unit V: Neuro Dynamics **9**

Dynamical Systems, Stability of Equilibrium States, Attractors, Neuro Dynamical Models, Manipulation of Attractors as a Recurrent Network Paradigm Hopfield Models – Hopfield Models, restricted Boltzmann machine.

TEXTBOOK

1. Cheng and H. He, *Neural Networks for Autonomous Vehicles: Fundamentals and Applications*. Cham, Switzerland: Springer, 2020.
2. S. Siddharth, *Deep Learning for Autonomous Vehicles: Driving the Future*. Birmingham, UK: Packt Publishing, 2020.
3. B. Li and R. Shapovalov, *Hands-On Machine Learning for Autonomous Vehicles: Develop and Implement Machine Learning Models for Self-Driving Cars using TensorFlow and Keras*. Birmingham, UK: Packt Publishing, 2020.

REFERENCE BOOKS

1. Maurer, J. C. Gerdes, B. Lenz, and H. Winner, Eds., *Autonomous Driving: Technical, Legal and Social Aspects*. Cham, Switzerland: Springer, 2016.
2. K. P. Murphy, *Machine Learning: A Probabilistic Perspective*. Cambridge, MA: MIT Press, 2012.
3. W. Ritter and C. Stiller, *Artificial Intelligence for Autonomous Driving: How Neural Networks Enable Autonomous Vehicles*. Cham, Switzerland: Springer, 2020.

Online Study Material

1. **Coursera**:
   - Courses on deep learning, neural networks, and autonomous vehicles offered by universities and technology companies.
2. **Udacity**:
   - Nanodegree programs on self-driving cars, computer vision, and machine learning for autonomous systems.
3. **YouTube Channels**:
   - Tutorials, lectures, and demonstrations on neural networks, deep learning, and autonomous vehicles from channels such as NVIDIA AI, Siraj Raval, and Lex Fridman.
4. **GitHub Repositories**:
   - Open-source projects, code repositories, and tutorials on neural network-based algorithms and models for autonomous driving.
5. **Research Papers and Journals**:
   - Academic papers and journals on artificial intelligence, machine learning, and autonomous vehicles are available through online databases such as IEEE Xplore, arXiv, and Google Scholar.

EIGHTH SEMESTER

AVAS481 (AV8MJ21): SATELLITE & RADAR COMMUNICATION FOR AVS

L	T	P	C	45L
3	0	2	4	

Prerequisites

- Background in telecommunications or electrical engineering.
- Understanding of basic concepts in signal processing and communication systems.
- Proficiency in mathematics, especially in calculus and probability theory.
- Familiarity with electromagnetic theory and transmission principles.

Course Objective

- Introduce fundamental concepts and principles of satellite communication systems.
- Teach satellite orbits, link budget analysis, modulation, and multiple access techniques.
- Explore satellite system design, antennas, and earth station technology.
- Enable students to understand satellite applications and system constraints.
- The main objective of the course is to provide a comprehensive and state-of-the-art knowledge in the area of satellite communication and radar Systems.

Course Outcome

- Understanding of satellite communication principles, protocols, and standards.
- Explain Basic Concepts and Terminologies of Satellite Communication
- Design the Earth Station and Space Craft System
- Calculate the Link Power Budget Including Propagation Effects in Satellite.
- Evaluate the Various Performance Factors Related to the RADAR
- Explain target Detection and Tracking using Radar Systems.

Unit I: Introduction **9**

Introduction to Satellite Communication, Origin and History of Satellite Communication, Current State of Satellite Communication, Orbital Aspect of Satellite Communication, Orbital Mechanism, Equation of Orbit, Locating Satellite in Orbit, Orbital Elements, Orbital Perturbation, Frequency Allocations and Applications.

Unit II: Space Craft Sub System and Earth Station **9**

Altitude and Orbit Control System, Telemetry Tracking and Command Power System, Communication Sub System, Earth Station Design, Antenna Tracking, LNA, HPA, RF, Multiplexing Factor Affecting Orbit Utilization, Tracking, Equipment for Earth Station.

Unit III: Satellite Link Design **9**

Satellite Link Design, System Noise Temperature and G/T Ratio, Downlink Design, Domestic Satellite System, Uplink Design, Earth Path Propagation Effect, Losses in Link Design.

Unit IV: Introduction to Radar **9**

Principles of RADAR, Radar Frequencies, Pulse Radar, Radar Range Equation, Radar Application, Radar Cross Section of Targets Radar Indicator, Noise Figure of Receiver, Mixer Duplexer, Line Pulsar.

Unit V: Operational Radar **9**

MTI Radar, Delay Line Canceller, Digital Signal Processing, Limitation of MTI Radar, CW Radar, FM CW Radar.

TEXTBOOK

1. T. Pratt and C. Bostian, *Satellite Communication*. Hoboken, NJ: John Wiley & Sons, 2007.
2. R. J. Boyle, *Understanding Satellite Communications*. New York, NY: Artech House, 1997.
3. T. Pratt, J. E. Allnutt, and D. Roddy, *Satellite Communications*, 4th ed. Hoboken, NJ: John Wiley & Sons, 2020.
4. B. R. Elbert, *Introduction to Satellite Communication*. Boston, MA: Artech House, 2008.
5. L. J. Ippolito, *Satellite Communications Systems Engineering*. Hoboken, NJ: John Wiley & Sons, 2017.
6. M. O. Kolawole, *Satellite Communication Engineering*. New York, NY: Marcel Dekker, 2002.

REFERENCE BOOKS

1. T. T. Ha, *Digital Satellite Communication Systems*. New York, NY: McGraw-Hill, 1990.
2. W. L. Pritchard and J. A. Sciulli, *Satellite Communication Systems Engineering*. New Delhi, India: PHI Learning, 1986.
3. R. M. Gagliardi, *Satellite Communications*. Hoboken, NJ: John Wiley & Sons, 1988.
4. M. Richharia, *Satellite Communication Systems: Design Principles*. London, UK: Macmillan Publishers, 1996.
5. G. Maral and M. Bousquet, *Satellite Communications Systems Design*, 3rd ed. Hoboken, NJ: John Wiley & Sons, 2009.
6. T. M. Braun, *Satellite Communications Payload and System*. Hoboken, NJ: John Wiley & Sons, 2012.
7. G. E. Corazza, *Digital Satellite Communications*. Berlin, Germany: Springer, 2007.

SATELLITE & RADAR COMMUNICATION FOR AVS LAB

List of Exercises **30**

1. To set up a satellite communication link and study of change in uplink and downlink frequency.
2. To establish an Audio-Video satellite link between Transmitter and Receiver
3. To Study Frequency Hopping Spread Spectrum (FHSS) Modulation and Demodulation Technique.
4. To study generation (spreading) & demodulation (Despreading) of DSSS modulated signal.
5. To study radiation pattern & calculate beam width for Yagi uda & folded dipole antenna.
6. To study radiation pattern & calculate beam width for circular & triangular patch. Antenna.
7. Study of Data and PN Sequence Generation.

8. To study GPS data like longitude, latitude using GPS receiver Study of Minimum Shift Keying (MSK) Modulation Process Study of Minimum Shift Keying (MSK) Demodulation Process.

AVAS482 (AV8MJ22): MEASUREMENTS AND EXPERIMENTAL TESTING

L	T	P	C	45L
3	0	2	4	

Prerequisites: NIL

Course Objective

- This course will help in understanding the importance of understanding basic concepts related to mechanical measurements and advanced available measurement techniques and their use.

Course Outcome

- Understanding of Measurement Principles.
- Proficiency in Measurement Techniques.
- Ability to Design Experimental Setups.
- Skill in Data Collection and Analysis.
- Knowledge of Calibration Procedures.
- Awareness of Measurement Errors and Uncertainty.
- Competence in Experimental Design and Planning.

Unit I: Introduction to Measurement **9**

Mechanical measurement and importance of measurement from an industrial perspective, Classification of measurement system.

Unit II: Conventional Measurement Methods **9**

Conventional measurement methods - Sensors and transducers, displacement and acceleration.

Unit III: Gages **9**

Strain gages and extensometer; electrical resistance strain gages.

Unit IV: Principles and Applications of Measurements **9**

Measurement principle, error analysis and applications, error and standard deviation measurements and representation.

Unit V: Measurement Techniques **9**

Optical microscope, Electron Microscope, Laser-based systems, Surface profilers, SEM, AFM; digital image correlation.

TEXTBOOK

1. D. Placko, Ed., *Fundamentals of Instrumentation and Measurement*. Hoboken, NJ: John Wiley & Sons, 2013.
2. N. V. Raghavendra and L. Krishnamurthy, *Engineering Metrology and Measurements*. New Delhi, India: Oxford University Press, 2013.

REFERENCE BOOKS

1. J. G. Webster and H. Eren, *Measurement, Instrumentation, and Sensors Handbook: Spatial, Mechanical, Thermal, and Radiation Measurement*. 2nd ed. Boca Raton, FL: CRC Press, 2014.
2. J. P. Bentley, *Principles of Measurement Systems*. 4th ed. Harlow, UK: Pearson Education, 2005.

OTHER ONLINE STUDY MATERIALS

- MIT OpenCourseWare - Introduction to Experimental Physics**:**
- National Instruments - Measurement Fundamentals Tutorial**:**
- University of Cambridge - Measurement Techniques in Research**:**
- NIST Virtual Institute for Metrology - Metrology Resources**:**
- Khan Academy - Physics: Measurement and Uncertainty**:**
- LabX - Laboratory Equipment Marketplace**:**
- YouTube Channels**:**
  Channels like Physics Girl, Veritasium, and Practical Engineering provide engaging content on scientific concepts and experiments.

AVAS483 (AV8MJ23): INDUSTRIAL ROBOTICS AND AUTOMATION

L	T	P	C	45L
3	1	0	4	

Prerequisites

- Background in mechanical or electrical engineering.
- Understanding of basic robotics concepts and automation.
- Proficiency in programming languages, especially for control systems.
- Familiarity with kinematics, dynamics, and control theory.

Course Objective

- Introduce the fundamental concepts and principles of industrial robotics.
- Teach robot kinematics, dynamics, and control techniques.
- Explore robotic sensors, actuators, and vision systems used in industry.
- Enable students to design, program, and control industrial robotic systems.
- Focus on practical applications in manufacturing and automation.

Course Outcome

- Understanding of the basic principles and history of industrial robotics.
- Proficiency in designing and analysing industrial robotic systems.
- Capability to program and control robots for specific applications.
- Ability to evaluate and optimize robotic systems for industrial use.
- Skills to contribute to the development and implementation of industrial robots.

Unit I: Fundamentals of Robotics **9**

Classification of robots – robot anatomy – robot motions – work volume – robot driven system – types – dynamic performance – precision of movements – limited sequence robots – playback robot with PTP control – continuous path control – intelligent robots.

Unit II: Robot Control Systems and Components **9**

Basic control systems and models – concepts – control system analysis – robot activation and feed-back components – power transmission system – robot joint control design.

Unit III: Method of Robot Programming **9**

Lead through programming methods – capabilities and limitations – Textual robot languages – generations of robot programming language, robot language structure, constants, variables, and other data objects, motion comments, end effectors and sensor commands, computations and operations, program control and subroutines, communications and data processing, monitor mode commands.

Unit IV: Robot Cell Layouts **9**

Robot cell layouts – multiple robots and machine interface, consideration in work cell design, work cell control, interlocks, error detection and recovery, Robot cycle time analysis – graphical simulation of Robot work cells – AI and robotics.

Unit V: Robot Applications in Manufacturing **9**

Robot material handling, material transfer applications, loading and unloading – processing operation – spot welding, continuous arc welding, spray coating – assembly and inspection – parts presentation methods, assembly operations, compliance & the remote centre compliance device, assembly system configuration, designing for robotic assembly, inspection automation – future applications.

TEXTBOOK

1. R. D. Klafter, T. A. Chmielewski, and M. Negin, *Robotic Engineering: An Integrated Approach*. New Delhi, India: Prentice Hall of India Pvt. Ltd., 1989.
2. M. P. Groover, M. Weiss, R. N. Nagel, and N. G. Odrey, *Industrial Robotics: Technology, Programming, and Applications*. New York, NY: McGraw-Hill, 1986.
3. B. Siciliano, L. Sciavicco, L. Villani, and G. Oriolo, *Robotics: Modelling, Planning and Control*. London, UK: Springer, 2009.
4. P. Corke, Robotics, *Vision and Control: Fundamental Algorithms in MATLAB*. 2nd ed. Cham, Switzerland: Springer, 2017.

REFERENCE BOOKS

1. K. S. Fu, R. C. Gonzalez, and C. S. G. Lee, *Robotics: Control, Sensing, Vision, and Intelligence*. New York, NY: McGraw-Hill, 1987.
2. S. Y. Nof, *Handbook of Robotics. Hoboken*, NJ: John Wiley & Sons, 1985.
3. C. S. G. Lee, K. S. Fu, and R. C. Gonzalez, *Robotics: Control, Sensing, Vision, and Intelligence*. 1st ed. New York, NY: McGraw-Hill, 1987.
4. J. Lenarcic and O. Khatib, Eds., *Robotics: State of the Art and Future Challenges*. Berlin, Germany: Springer, 2003.
5. K. S. Fu, R. C. Gonzalez, and C. S. G. Lee, *Robotics: Principles and Practice*. 1st ed. New York, NY: McGraw-Hill, 1987.

Online Study Material

Websites:

- Coursera: Robotics Specializations and Courses.
- edX: Robotics and Control Systems Courses.
- ROS (Robot Operating System) Tutorials.
- IEEE Robotics and Automation Society resources.

Video Resources:

- YouTube channels like "Robotics Explained" and "Real Engineering"
- Online platforms like Coursera, Udacity, and edX offer courses on industrial robotics.

Simulation Tools:

- ROS and Gazebo for simulating robotic systems.
- MATLAB/Simulink or Python with libraries for robotic control.

Additional Resources:

- Access to robotics research papers and conference proceedings.
- Participation in robotics workshops and hands-on projects.

AVAS484 (AV8MJ24): DRONE TECHNOLOGIES

L	T	P	C	45L
3	1	0	4	

Prerequisites

- Background in Physics.
- Understanding of basic robotics concepts.
- Proficiency in programming languages, especially for control systems.
- Familiarity with aerospace fundamentals.

Course Objective

- To understand the basics of drone concepts
- To learn and understand the fundamentals of design, fabrication and programming of drone
- To impart the knowledge of a flying and operation of drone
- To know about the various applications of drone
- To understand the safety risks and guidelines of fly safely

Course Outcome

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

- Know about various types of drone technology, drone fabrication and programming.
- Execute the suitable operating procedures for functioning a drone
- Select appropriate sensors and actuators for Drones
- Develop a drone mechanism for specific applications
- Create programs for various drones

Unit I: Introduction to Drone Technology **9**

Drone Concept - Vocabulary Terminology- History of drone - Types of the current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability.

Unit II: Drone Design, Fabrication and Programming **9**

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts - Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

Unit III: Drone Flying and Operation **9**

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment-Drone Controls Flight operations –management tool –Sensors-Onboard storage capacity - Removable storage devices- Linked mobile devices and applications.

Unit IV: Drone Commercial Applications **9**

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing.

Unit V: Future Drones and Safety **9**

The safety risks- Guidelines to fly safely -Specific aviation regulation and Standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms.

TEXTBOOK

1. D. Tal and J. Altschuld, *Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation*. Hoboken, NJ: John Wiley & Sons, Inc., 2021.
2. T. Kilby and B. Kilby, *Make: Getting Started with Drones*. San Francisco, CA: Maker Media, Inc., 2016.
3. J. Baichtal, *Building Your Own Drones: A Beginners' Guide to Drones*, UAVs, and ROVs. Indianapolis, IN: Que Publishing, 2016.
4. P. Fahlstrom and T. Gleason, *Introduction to UAV Systems*. Hoboken, NJ: John Wiley & Sons, 2012.
5. S. Cassidy, *Drone Technology Handbook*. Scotts Valley, CA: CreateSpace Independent Publishing Platform, 2017.

REFERENCE BOOKS

1. J. Glover, *Drone University*. Charleston, SC: Createspace Independent Pub, 2016.
2. R. Harrington, *Mastering Drone Photography: Capture Stunning Aerial Photos and Videos with Your Drone*. Santa Barbara, CA: Rocky Nook, 2017.
3. D. John, *Drone Entrepreneurship: 30 Businesses You Can Start*. Scotts Valley, CA: Independently Published, 2018.
4. C. Valasek, *Unmanned Aircraft Systems (UAS): Role of Drones in the 21st Century*. Scotts Valley, CA: Independently Published, 2019.
5. N. Correll, B. Scassellati, and K. Yamokoski, *Introduction to Autonomous Robots: Mechanisms, Sensors, Actuators, and Algorithms*. Cambridge, MA: MIT Press, 2022.

Online Study Material

1. **Coursera**:
   - Drone Technology courses offered by institutions such as Stanford University, University of Pennsylvania, and Ecole Polytechnique Federale de Lausanne (EPFL).
2. **Udemy**:
   - Online courses on drone technology, drone piloting, and aerial photography and videography.
3. **YouTube Channels**:
   - Drone technology tutorials, reviews, and demonstrations from channels such as FliteTest, DroneDJ, and DroneDeploy.
4. **Federal Aviation Administration (FAA) - Unmanned Aircraft Systems (UAS)**:
   - Resources, guidelines, and regulatory information on drone operation and certification from the FAA.
5. **Drone Universities**:

- Online training programs and certification courses offered by drone universities and training academies.

6. **IEEE Xplore Digital Library**:
   - Research papers, articles, and publications on drone technology, robotics, and unmanned aerial systems.

AVAS485 (AV8MJ25): NON-DESTRUCTIVE TESTING METHODS

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Prerequisites

- Background in engineering, particularly materials or mechanical engineering.
- Understanding of materials properties and manufacturing processes.
- Knowledge of physics and mathematics, especially in wave propagation.
- Familiarity with inspection and quality control techniques.

Course Objective

- Introduce the principles and techniques of non-destructive testing (NDT).
- Teach various NDT methods such as ultrasonic, radiographic, magnetic particle, etc.
- Explore the applications, advantages, and limitations of different NDT techniques.
- Enable students to interpret and analyse test results for defect detection and evaluation.
- Focus on practical applications and real-world scenarios in industries.

Course Outcome

- Understanding of different NDT methods and their underlying principles.
- Proficiency in selecting and applying appropriate NDT techniques for specific materials and defects.
- Capability to interpret and evaluate test results for quality assessment.
- Ability to assess the reliability and limitations of NDT methods.
- Skills to contribute to the improvement and implementation of NDT processes.

Unit I: Non-Destructive Testing **9**

Introduction, classification of NDT techniques, Visual examination: Bore-scopes, video devices, Magnetic particle testing: Operating principal, magnetising technique. Liquid Penetrating technique: Principle, process description.

Unit II: Ultrasonic Testing **9**

Definition, advantages and applications, inspection methods. Radiography: Electromagnetic radiation sources, process description.

Unit III: Thermography **9**

Infrared theory, contact, non-contact methods. Acoustic emission testing, eddy current testing.

Unit IV: Leak testing **9**

Bubble emission testing, Air leak testing.

Unit V: Case Study **9**

Case studies on defects in casting, rolling, welding, and heat-treating.

TEXTBOOK

1. C. Hellier, *Nondestructive Testing Handbook*, 3rd ed. Columbus, OH: American Society for Nondestructive Testing, 2001.
2. P. McIntire, *Introduction to Nondestructive Testing: A Training Guide*. Hoboken, NJ: Wiley, 2010.
3. G. Smith, *Non-Destructive Testing*. London, UK: Macmillan, 1994.
4. J. Krautkrämer and H. Krautkrämer, *Ultrasonic Testing of Materials*. Berlin, Germany: Springer-Verlag, 1990.
5. M. W. Allen, *Radiographic Testing*. Oxford, UK: Butterworth-Heinemann, 1994.

REFERENCE BOOKS

1. W. J. McGomnagle, *Non-Destructive Testing*. New York, NY: McGraw-Hill, 1978.
2. B. Raj, T. Jayakumar, and M. Thavasimuthu, *Non-Destructive Testing*. New Delhi, India: Narosa Publishing House, 2002.
3. P. J. Shull, *Non-destructive Testing: Overview and Analysis*, 2nd ed. Hoboken, NJ: Wiley, 2016.
4. J. C. Drury, *Magnetic Particle Testing*. New York, NY: McGraw-Hill, 1991.
5. M. J. Loewenthal and K. T. Jacob, *Eddy Current Testing*. Columbus, OH: American Society for Nondestructive Testing, 1984.

Online Study Material

Websites:

- ASNT (American Society for Nondestructive Testing) Learning Center
- NDT Resource Center: Online tutorials and resources
- TWI (The Welding Institute): Non-Destructive Testing Information

Video Resources:

- YouTube channels like "ASNTinfo" and "NDT Classroom"
- Online platforms providing NDT courses and tutorials.

Simulation and Tools:

- Virtual simulators for practising different NDT techniques.
- NDT software for data analysis and interpretation.

Additional Resources:

- Access to industry-specific case studies and research papers in NDT.
- Participation in NDT workshops, seminars, and hands-on demonstrations.
- Collaboration with professionals and practitioners in the NDT field.