SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
P. G. DEPARTMENT OF APPLIED ELECTRONICS
Faculty of Science and Technology

Programme: M. Sc. (Applied Electronics)

PROGRAMME OUTCOMES (POs)

Upon completion of the M.Sc. Applied Electronics Programme, the student would be able to:

PO1	Deep subject Knowledge and intellectual breadth	Develop extensive knowledge in various areas of Electronics.
PO2	Professional Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the standard practices.
PO3	Creative & Critical Thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO4	Innovation, Research and Problem Solving	Identify, formulate, review research literature, and analyse problems using the first principles of mathematics and engineering sciences. Apply the knowledge of mathematics, science, engineering fundamentals and electronics to the solution of problems. Design solutions for electronic and allied systems, system modules or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. Demonstrate the knowledge of, and need for sustainable development.
PO5	Team work and Communication Skills	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. Present/communicate research at national/international level, write effective articles, reports and design documentation, make effective presentations, and give and receive clear instructions. Communicate disciplinary knowledge to the community and broader public.
PO6	Professionalism and Leadership Readiness	Demonstrate personal accountability and effective work habits, e.g., punctuality, working productively with others, and time as well as workload management. Use the strengths of others to achieve common goals
PO7	Lifelong learning	Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.
PO8	Competence for Digital World	Prepare well for living, learning and working in a Digital Society; Choose and apply appropriate modern tools/frameworks/platforms/instruments, software simulators, techniques, resources, and modern engineering and ICT tools to complex activities with an understanding of the limitations. Use existing digital technologies ethically and efficiently to solve problems, complete tasks, and accomplish goals.
PO9	Global Citizenship	Act with an informed awareness of global issues. Engage in initiatives that encourage equity and growth for all.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

At the end of the two-year M. Sc. Applied Electronics programme, the student would be able to

PSO 1: Analyze specific problems relevant to Applied Electronics by applying the knowledge of Electronic Devices and Circuits, Linear and Digital Integrated Circuits, Communication Engineering, Analog and Digital Electronics, Microprocessors, Microcontrollers, VLSI, Embedded Systems, Smart Sensors, Digital Signal Processing, Microwave Engineering, Embedded System Design, Computer Organization, Optical Fiber Communications, Mobile Communications, etc.

PSO 2: Design systems containing hardware and/or software using the significant analytical knowledge in Electronics and applying modern product development tools/frameworks.

PSO 3: Apply and transfer interdisciplinary systems and Engineering approaches to the various areas, like Communications, Signal processing, VLSI and Smart Sensors.

PSO4: Demonstrate skills by carrying out cost-effective projects with a flexibility to balance between research- and application- oriented work that require innovative approaches.

Employability Potential of the Programme

M. Sc. AE programme focuses on applied Sciences and engineering courses. Initially, it was started in the Faculty of Engineering and Technology with a view to provide exposure to applied sciences, courses relevant to electronics engineering and allied disciplines. In the past, many students have been placed in MNCs including but not limited to Oracle, Tektronix, Infosys, TCS, Cognizant, Persistent, Scientech, IBM, Marvell, BSNL, Tech Mahindra, Syntel, L&T Infotech, Videocon, CDAC, Samsung, Robonics Pvt Ltd., Jindal Saw Ltd., Electronics Art Pvt Ltd., etc.

Further, numerous students have completed their Master of Electronics Engineering as well as Ph.D. in Electronics Engineering and joined esteemed institutions like Indian Institute of Technology, Guwahati, Sant Gadge Baba Amravati University, Amravati as Professors and amongst them, a few have been leading the departments and institutes as HoDs and Principals, respectively. Some other students have been placed in banking sector such as HDFC Bank, ICICI Bank, Equitas Bank, Canara Bank, etc. Moreover, some students have secured jobs in Indian Navy, Merchant Navy, Ministry of Defence, Airport Authority of India, BSNL, etc. In addition, some students have successfully established their small enterprises and now they are self-employed. Nevertheless, they are providing jobs to other students as well.

Applied Electronics contributes to a lot of innovation in the fields of healthcare, automation, automotive, robotics and computer & IT. Because of the stupendous technological growth all over the world, there exist several jobs in electronics sector. Almost, everything runs on electrical devices, gadgets, and control systems, one can't do without electronics graduate in the company. Being an electronics graduate will act as an entrance in varied industries including Automotive Industry, Defence Industry, Real Estate, Construction, Electronics Industry, Marine Industry, Oil and Gas Industry, Power generation industry, Railways, Marine, Telecom industry, and many more.

Student can work in a variety of areas, as electronics are used in many things including but not limited to acoustics, defence, medical instruments, mobile phones, nanotechnology, radio and satellite communication, robotics, etc.

As a responsibility, student will need to:

- discuss proposals with clients
- work with colleagues to design new systems, circuits and devices or develop existing technology
- test theoretical design
- write specifications and technical reports
- follow defined development processes
- systematically improve the detailed design of a piece of electronic equipment
- ensure that a product will work with devices developed by others, can be made again reliably, and will perform consistently in specified operating environments
- create user-friendly interfaces
- ensure safety regulations are met
- carry out project planning and prepare budgets
- supervise technicians, craftspeople and other employees

Popular Job Profiles for Students of M Sc Applied Electronics

Students can work in a variety of manufacturing (product) and service sector organisations, including broadcasting, consulting, data communication, entertainment, research and development, and system support. The following are some of the most common job titles for an electronics and communication engineer. Areas of employment include but not limited to Service Engineer, Electronics Engineer, Electronics Design Engineer, Field Test Engineer, Communications Engineer, Customer Support Engineer, Field Test Engineer, Network Planning Engineer, Electronics and Communications Consultant, Electronics Technician, Research and Development Software Engineer, Senior Sales Manager, Technical Director, Analog applications engineer, Telecom engineer, VLSI and embedded systems (Automation) industries, Data processing industries

Self-Employment / Start-ups/Business Prospects for M Sc Applied Electronics students

Self-employment does cater the best jobs for students. However, establishing a start-up is likely to be risky at the initial stages. But a well-trained student can always try to broaden his/her business prospect by accumulating valuable knowledge. Moreover, gaining appropriate skills during the programme helps one to frame a strategic plan and execute it ideally.

Since in the current scenario, there are not a lot of start-ups in the Electronics industry, so competition would be comparatively less. A start-up in this field could be incorporated in any of the following avenues: Smart sensors, Robotics, VLSI, Optical Communication, Embedded Systems, Digital Electronics and many more.

Why contemplate higher studies after M.Sc. Applied Electronics?

With a degree in higher studies, students can increase the chances of career options. Students can join M.E. or M. Tech. Programmes in Electronics Engineering. Master degrees offer to reinforce fundamental concepts in areas like communication, machine learning, high processing circuits etc. In addition, a higher degree in education can support with greater job opportunities and advanced level training that cannot be acquired during graduation level education.

Additionally, higher studies apart from providing several advantages, job opportunities for electronics and communication engineers, also strengthen the existing knowledge foundation. It permits an individual career aspirant to move across the global landscape to experience professional growth seamlessly.

To summarize, students can explore global career opportunities and switch job roles smoothly. They can grab high salary packages. They can enhance knowledge and skills. Job security is ensured and enormous career advantages are gained. Consequently, this results in building strong networks.

Appendix-A

Master of Science (M.Sc. Applied Electronics) Full Time Two Years Degree Programme :-

1) A Student shall have to be admitted every year in the respective Institute/ College/University Department for completion of an academic year of this two year Degree programme.
2) The M.Sc. Degree shall consist of four semesters i.e. Semester I & II in the first academic year, Semester III & IV in the second academic year.
3) Student has to complete all four Semesters successfully for the award of Degree of Master of Science and fulfill conditions as per Ordinance No. 19.
4) Every Semester of M.Sc. Applied Electronics programme shall be of at least 90 teaching days in a semester and shall be of at least 180 teaching days in an academic year.
5) The Examinations shall consist of the subjects as indicated in the Scheme of Examinations as per **Appendix – 'A1 to A4'.**

6) The Semester wise structure of the programme is as follows.

Appendix- A1

Sant Gadge Baba Amravati University Amravati

Scheme of Teaching, Learning & Examination leading to the Degree Master of Science (Applied Electronics)

(Two Years- Four Semesters Degree Programme- C.B.C.S)

(M. Sc. Part-I) Semester- I

S. N.	Subject	Subject Code	Teaching & Learning Scheme							Duration Of Exam Hours	Examination & Evaluation Scheme						
			Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing	
											Theory		Practical		Total Marks		
			L	T	P	Total	L/T	Practical	Total		Theory+ MCQ External	Theory Internal	Internal	External		Marks	Grade
1	Electrical Engineering & Network Analysis (DSC-1)	1AE1	4	1	-	5	5	-	5	3	80	20			100	40	P
2	Electronic Devices and Circuits (DSC-2)	1AE2	4	1	-	5	5	-	5	3	80	20			100	40	P
3	Communication Engineering (DSC-3)	1AE3	4	1	-	5	5	-	5	3	80	20			100	40	P
4	Object Oriented Programming C++ (DSC-4)	1AE4	4	1	-	5	5	-	5	3	80	20			100	40	P
5	Electric & Magnetic Fields (DSC-5)	1AE5	4	1	-	5	5	-	5	3	80	20			100	40	P
6	Electrical Engineering & Network Analysis (DSC-1) Laboratory	1AE6	-	-	2	2	-	1	1	3			25	25	50	25	P
7	Electronic Devices and Circuits (DSC-2) Laboratory	1AE7	-	-	2	2	-	1	1	3			25	25	50	25	P
8	Object Oriented Programming C++ (DSC-4) Laboratory	1AE8	-	-	2	2	-	1	1	3			25	25	50	25	P
9	Basic Electronic Workshop Laboratory (AEC-1)	1AE9			2	2	-	1	1	3			25	25	50	25	P
10	**#Internship/Field Work/Work Experience @**	1AE10															
11	**Open elective/ GIC/Open skill/MOOC***	1AE11															P
	TOTAL					33			29						700		

L: Lecture, T: Tutorial, P: Practical

Students may complete their Internship/Field Work/Work Experience in First OR Second OR Third Semester of M. Sc. (Applied Electronics) according to their convenience; @ denotes Ancillary Credit

Note : Internship /Apprenticeship/Field Work / Work Experience (During vacations of Semester I to Semester III) for duration of minimum 60 hours to maximum 90 hours mandatory to all the students, to be completed during vacations of Semester I to III. This will carry 2 Credits for learning of 60 hours or 3 Credits for learning of 90 hours. Its credits and grades will be reflected in final semester IV credit grade report.

- OEC (Optional) can be studied during semester I to IV

DSC: Discipline Specific Core, DSE: Discipline Specific Elective, AEC: Ability Enhancement Course, SEC: Skill Enhancement Course, GIC: General Interest Course

Appendix- A2

Sant Gadge Baba Amravati University Amravati

Scheme of Teaching, Learning & Examination leading to the Degree Master of Science (Applied Electronics)

(Two Years- Four Semesters Degree Programme- C.B.C.S)

(M. Sc. Part-I) Semester- II

S. N.	Subject	Subject Code	Teaching & Learning Scheme							Duration Of Exam Hours	Examination & Evaluation Scheme						
			Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing	
											Theory		Practical		Total Marks		
			L	T	P	Total	L/T	Practical	Total		Theory+ MCQ External	Theory Internal	Internal	External		Marks	Grade
1	Linear Integrated Circuits DSC-6	2AE1	4	1	-	5	5	-	5	3	80	20			100	40	P
2	Mobile Communication DSC-7	2AE2	4	-	-	4	4	-	4	3	80	20			100	40	P
3	AEC-2 on DSC-7	2AE3	-	1	-	1	1	-	1	1	-	-	25	-	25	10	P
4	Digital Integrated Circuits DSC-8	2AE4	4	1	-	5	5	-	5	3	80	20			100	40	P
5	Microprocessor and Microcontroller DSC -9	2AE5	4	1	-	5	5	-	5	3	80	20			100	40	P
6	**Professional Elective –** DSE-1	2AE6X	4	1	-	5	5	-	5	3	80	20			100	40	P
7	Integrated Circuits (DSC-6 & DSC-8) Laboratory	2AE7	-	-	2	2	-	1	1	3			25	25	50	25	P
8	Professional Elective (DSE-1) Laboratory	2AE8X	-	-	2	2	-	1	1	3			25	25	50	25	P
9	Microprocessor and Microcontroller (DSC-9) Laboratory	2AE9	-	-	2	2	-	1	1	3			25	25	50	25	P
10	**#Internship/Field Work/Work Experience@**	2AE10															
11	**Open elective/ GIC/Open skill course/MOOC***	2AE11															
	TOTAL					31			28						675		

2AE6x DSE: 2AE61 Electronic Instrumentation, 2AE62 Control Systems, 2AE63 Introduction to Data Science and Neural networks

Students may complete their Internship/Field Work/Work Experience in First OR Second OR Third Semester of M. Sc. (Applied Electronics) according to their convenience; @ denotes Ancillary Credit

DSC: Discipline Specific Core, DSE: Discipline Specific Elective, AEC: Ability Enhancement Course, SEC: Skill Enhancement Course, GIC: General Interest Course

Appendix- A3

Sant Gadge Baba Amravati University Amravati

Scheme of Teaching, Learning & Examination leading to the Degree Master of Science (Applied Electronics)

(Two Years - Four Semesters Degree Course- C.B.C.S)

(M. Sc. Part-II) Semester- III

S. N.	Subject	Subject Code	Teaching & Learning Scheme							Duration Of Exam Hours	Examination & Evaluation Scheme						
			Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing	
											Theory		Practical				
			L	T	P	Total	L/T	Practical	Total		Theory+ MCQ External	Theory Internal	Internal	External	Total Marks	Marks	Grade
1	Digital Signal Processing DSC-10	3AE1	4	1	-	5	5	-	5	3	80	20			100	40	P
2	Embedded System Design DSC-11	3AE2	4	-	-	4	4	-	4	3	80	20			100	40	P
3	AEC-3 on DSC-11	3AE3	-	1	-	1	1	-	1	1	-	-	25	-	25	10	P
4	Internet of Things –IOT (SEC)	3AE4	-	1	-	1	1	-	1	1	-	-	25	-	25	10	P
5	**Professional Elective –** DSE-2	3AE5X	4	1	-	5	5	-	5	3	80	20			100	40	P
6	**Open elective/ GIC/Open skill course/MOOC***	3AE6															
7	Digital Signal Processing (DSC-10) Laboratory	3AE7	-		2	2	-	1	1	3	-	-	25	25	50	25	P
8	Embedded System Design (DSC-11) Laboratory	3AE8	-	-	2	2	-	1	1	3			25	25	50	25	P
9	Project and Seminar	3AE9	-	-	6	6	-	3*	3*	-			--	--	--	--	--
10	IOT (SEC) Lab.	3AE10	-	-	2	2	-	1	1	3			25	25	50	25	P
11	Project (IOT SEC)	3AE11			1	1	-	1	1	1	-	-	25	25	50	25	P
12	**#Internship/Field Work/Work Experience@**	3AE12															
						29			23*						550		

3AE5x Professional Elective : 3AE51 Smart Sensors, 3AE52 Remote Sensing, 3AE53 Computer Architecture [*Note: Board of Studies will prepare pool of electives]

Open Elective (OEC) GIC /Open Skill Course (within faculty or interfaculty) / MOOC /(5 credits for each)

Students may complete their Internship/Field Work/Work Experience in First OR Second OR Third Semester of M. Sc. (Applied Electronics) according to their convenience; @ denotes Ancillary Credit

*Credits of Project and Seminar (3AE9) shall be carried forward and added to the Fourth Semester in 4AE8

DSC: Discipline Specific Core, DSE: Discipline Specific Elective, AEC: Ability Enhancement Course, SEC: Skill Enhancement Course, GIC: General Interest Course

Appendix- A4

Sant Gadge Baba Amravati University Amravati

Scheme of Teaching, Learning & Examination leading to the Degree Master of Science (Applied Electronics)

(Two Years - Four Semesters Degree Course- C.B.C.S)

(M. Sc. Part-II) Semester- IV

S. N.	Subject	Subject Code	Teaching & Learning Scheme							Duration Of Exam Hours	Examination & Evaluation Scheme						
			Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing	
											Theory		Practical		Total Marks		
			L	T	P	Total	L/T	Practical	Total		Theory+ MCQ External	Theory Internal	Internal	External		Marks	Grade
1	Microwave Engineering DSC-12	4AE1	**4**	**1**	**-**	**5**	**5**	**-**	**5**	**3**	**80**	**20**			**100**	**40**	**P**
2	Optical Fiber Communications DSC - 13	4AE2	**4**	**1**	**-**	**5**	**5**	**-**	**5**	**3**	**80**	**20**			**100**	**40**	**P**
3	VLSI Design DSC-14	4AE3	**4**	**-**	**-**	**4**	**4**	**-**	**4**	**3**	**80**	**20**			**100**	**40**	**P**
4	AEC-4 on DSC-14	4AE4	**-**	**1**	**-**	**1**	**1**	**-**	**1**	**1**	**-**	**-**	**25**	**-**	**25**	**10**	**P**
5	Digital Communication DSC-15	4AE5	**4**	**1**	**-**	**5**	**5**	**-**	**5**	**3**	**80**	**20**			**100**	**40**	**P**
6	**Professional Elective :** DSE-3	4AE6X	**4**	**1**	**-**	**5**	**5**	**-**	**5**	**3**	**80**	**20**			**100**	**40**	**P**
7	Microwave Engineering and Optical Fiber Communications (DSC-12 & DSC-13) Laboratory	4AE7	**-**	**-**	**2**	**2**	**-**	**1**	**1**	**3**	**-**	**-**	**25**	**25**	**50**	**25**	**P**
8	Project and Seminar	4AE8 **3AE9**	**-**	**-**	**6**	**6**	**-**	*	**3+3**	**3**	**-**	**-**	**100**	**100**	**200**	**100**	**P**
9	**#Internship/Field Work/Work Experience@**	4AE9															
10	**Open elective/ GIC/Open skill course/MOOC***	4AE10															
						33			**32**						**775**		

4AE6x Professional Elective#: 4AE61 Artificial Intelligence, 4AE62 Biomedical Engineering 4AE63, Computer Networks

4AE9# includes its equivalent predecessors **1AE11/2AE10/3AE12** and it denotes the **Internship/Field Work/Work Experience** undertaken and completed by students in the preceding semesters' vacations, viz., First OR Second OR Third Semester

*Credits of Project and Seminar (3AE9) have been carried forward and added to the Fourth Semester in 4AE8, so that the Total Credits for Project and Seminar add up to 6 (3 +3)

DSC: Discipline Specific Core, DSE: Discipline Specific Elective, AEC: Ability Enhancement Course, SEC: Skill Enhancement Course, GIC: General Interest Course

SYLLABUS PRESCRIBED FOR TWO YEAR
P.G. DEGREE COURSE MASTER OF SCIENCE (APPLIED ELECTRONICS) SEMESTER PATTERN
SEMESTER: FIRST

1AE1 ELECTRICAL ENGINEERING AND NETWORK ANALYSIS

COs (Course Outcomes)

After successfully completing the course, the students would be able to

1. Analyze electrical circuits using mesh and node analysis.
2. Apply suitable network theorems to analyze electrical circuits.
3. Apply Laplace Transform for circuit analysis.
4. Draw oriented graph of network to determine their currents and voltages.
5. Understand the theory for network analysis
6. Apply two-port network analysis in the design and analysis of filter and attenuator networks

Unit I : Fundamentals of Electrical Engineering
Basic concept of voltage, current, work, power and energy, relationships between them, Resistance, resistivity, conductivity, Ohm's law, series and parallel connections of resistors, voltage and current division, Star to delta and delta to star transformations, Kirchhoff's laws applied to dc circuits, single phase AC Circuits (sinusoidal waveforms only), R-L-C series circuits and parallel circuits, phasor diagram, impedance triangle, active reactive power. (10 Hrs)

Unit II : Single phase transformer
Principle of operation, construction, EMF equation of transformer, voltage transformation ratio, transformer on no load, transformer on load, losses in transformer, voltage regulation of transformer, efficiency of transformer, condition for maximum efficiency. Basic Network Elements and sources Network elements, circuit components, assumptions for circuit analysis, voltage and current sources, Standard input signals, source transformations, mesh and node analysis. (10 Hrs)

Unit III : Graph theory and network equations
Graph of a network, Trees, co trees and loops, Incidence matrix, Cut-set matrix, Tie set matrix and loop currents, possible trees, analysis of a network using Kirchoff's laws, network equilibrium equation and Duality network transformations. (10 Hrs)

Unit IV : Laplace Transformation and its applications
Laplace transformations, basic theorems, Laplace transform of some important functions, initial and final value theorem, gate function, impulse function, Solutions of linear differential equations with constant coefficients, Heaviside's partial fraction expansion. (10 Hrs)

Unit V : Network Theorems
Introduction, Superposition theorem, Reciprocity theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem applied to DC and AC circuits. (10 Hrs)

Unit VI : Two-Port Network
Open circuit impedance parameters, short circuit admittance parameters, Transmission or chain parameters, Hybrid parameters, Interrelationships between the parameters, Interconnection of two port networks, Input impedance in terms of two port parameters, Output impedance in terms of two port parameters. (10 Hrs)

Text Books:

1) De Carlo Lin : Linear Circuit Analysis, 2e, Oxford University Press
2) D. Roy Choudhary : Network and Systems (New Age International/ Wiley eastern ltd)
3) V.N. Mittle : Basic Electrical Engineering, (TMGH)

Reference Books:

1) M.E. Van Valkenburg : Network analysis 3rd Ed. (PHI)
2) Iskv Iyer : Circuit Theory, (TMGH)
3) Edminister : Electric Circuits, Schaum Outline Series

Link for MOOCS: https://onlinecourses.nptel.ac.in/noc20_ee68/preview
https://onlinecourses.nptel.ac.in/noc22_ee07/preview

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1AE2 ELECTRONIC DEVICES AND CIRCUITS

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Apply the knowledge of diode and its applications in rectifier and regulator circuits.
2. Understand basics of BJT, JFET, MOSFET, UJT and their operational parameters.
3. Understand feedback concept, topologies and their applications.
4. Implement and analyze various electronic circuits such as oscillators, multistage amplifiers and power amplifiers using BJT.
5. Design and analyze electronic circuits.
6. Compare working of various diodes and their applications

Unit I : P-N Junction diode theory, Rectifiers - Half wave, full wave and bridge, Filters-C, LC and their analysis, analysis of clipping and clamping circuits using diodes, Zener diode and its application. (10 Hrs)

Unit II : Theory and Analysis of Bipolar Junction transistor, Configurations, transistor as a switch,'Q' and stability factor, Methods of biasing, their needs, 'h' Parameter (CE, CB, CC analysis) (10 Hrs)

Unit III : FETs (JFET & MOSFET): Types, Characteristics and parameters (μ , gm, Rds), Biasing of FET, MOS capacitor, Equivalent circuits of JFET and MOSFETs, CMOS characteristics. (08 Hrs)

Unit IV : Study of typical transistor amplifier circuits: BJT: RC coupled amplifier, Transformer coupled amplifier, Direct coupled amplifier, Cascode stage, Emitter follower, Darlington emitter follower, Bootstrap emitter follower, Feedbackamplifiers. FET Amplifier-Common Source & Common Drain. (12 Hrs)

Unit V : Class 'A', 'B', 'AB' and 'C' amplifiers, Calculations of power gain, efficiency, power dissipation and distortion, Oscillators, their criteria, Hartley, Colpitts and R-C Oscillators, Crystal Oscillator. (10Hrs)

Unit VI : Theory, Construction and applications of Schottky diode, Tunnel diode, Varactor diode, LED, Photo diode, Phototransistor, PIN diode. (10 Hrs)

Text Books:

1) Electronic Devices and	:	David A. Bell, Oxford University Press
2) Electronic Devices and Circuits	:	Millman and Halkias, TMGH
3) Integrated Circuits	:	Millman and Halkias, TMGH
4) Microelectronics	:	Millman and Halkias, TMGH
5) Millman and Taub	:	Pulse, Digital and Switching wave forms (TMGH)

Reference Books:

1)	Microelectronic Circuits	:	Sedra/Smith,5e,Oxford University Press
2)	Electronic Devices & Circuit Theory	:	R.L. Boylestad & L. Nashlsky (6th Edition), Pearson Education
3)	Semiconductor Devices and Circuits	:	Aloke K. Dutta, Oxford University, Press

Link for MOOCS: https://nptel.ac.in/courses/122106025

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1AE3: COMMUNICATION ENGINEERING

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Understand the necessity of modulation and identify the various components of analog communication systems.
2. Analyse different modulation and demodulation schemes in analog and pulse communication systems.
3. Analyze the performance of analog communication systems in presence of noise.
4. Develop the ability to compare and contrast the strengths and weaknesses of various communication systems.
5. Compare the performance various AM receivers
6. Draw block diagram and explain working of FM transmitter and Receiver

Unit I : Basics of Electronic Communication

The importance of electronic communication, Definition: Analog signal, Digital signal, Baseband signal, block diagram of basic electronic communication system and explanation of each block, Noise in communication system and types, The electromagnetic spectrum, Concept of transmission bandwidth, modulation, need for modulation, different modulation techniques, Difference between CW and pulse modulation techniques. (Fundamental concepts) (10 Hrs)

Unit II : Wave Propagation

Fundamentals of Electromagnetic waves, ground waves, space waves propagation, ionosphere layer, sky waves propagation, concept of actual and virtual height, Definitions of critical frequency, maximum usable frequency, skip distance and skip zone, concept of fading. (10 Hrs)

Unit III: Antennas

Antenna fundamentals, concept of Radiation pattern, polarization, bandwidth, beam width, antenna resistance, directivity, power density, antenna gain, Structure, radiation pattern & applications of -Half wave dipole antenna (resonant antenna), folded dipole antenna, Yagi-Uda antenna. (10 Hrs)

Unit IV : AM transmitters

Amplitude Modulation, Modulation index-definition, its effect on modulated signal, Mathematical representation of amplitude modulated wave & its meaning, concepts of side band (SSB,DSB), Power relations in AM wave, simple numerical, Circuit and operation of AM modulator using FET, Block diagram of AM transmitter and its operation, advantages, disadvantages, applications of AM. (10 Hrs)

Unit V : AM receivers

Block diagram of Tuned Radio Frequency receiver and its working, Block diagram of AM super heterodyne receiver and its working, Characteristics of AM radio receiver- Sensitivity, selectivity, fidelity definitions, Image frequency and its rejection, Demodulation of AM signal, Diode detector, Need of AGC & its types – simple, delayed. (10 Hrs)

Unit VI : FM transmitter and Receiver

Frequency Modulation, mathematical representation of FM & its meaning, direct FM Generation using FET,Armstrong circuit diagram and its working, Concept of Pre-emphasis & De-emphasis

FM receiver: Block diagram and explanation of FM Super heterodyne radio receiver, Balanced slope detector. (10 Hrs)

Text Books: 1) Kennedy G. : Electronic communication system (Mc-Graw Hill) 4th Ed

2) Dennis Roddy & John Coolen : Electronic communication (PHI) 2ND Ed

Link for MOOCS: https://nptel.ac.in/courses/117102059

1AE4 OBJECT ORIENTED PROGRAMMING C++

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Explain the basics of object-oriented programming concepts such as data types, functions, classes, objects, constructors, inheritance, overloading etc.
2. Design, implement, test, and debug simple programs in an object-oriented programming language.
3. Describe how the class mechanism supports encapsulation and information hiding.
4. Design and test the implementation of C++ programming concepts
5. Create and analyze algorithms for solving simple problems
6. Apply the concepts and principles of the programming language to the real-world problems

Unit-I : Introduction to object-oriented programming, comparison with structured programming object oriented terminology data abstraction, Inheritance, polymorphism. (8Hrs)

Unit-II : New keywords, type compatibility, scope operator, function in C++, function prototype, In line function, Default argument, Overloading, Operator overloading, Unary operator, Binary operator. (10 Hrs)

Unit-III : Class: definition, Object, Data member and instance variable methods, Implicit object, class scope, Access specifier, Operator method, Constructor, Copy constructor, Destructor, Assignment calls, Static member, Dynamic objects,Array of objects, Friend functions, Pointer to member. (12Hrs)

Unit-IV : Inheritance and polymorphism**:** simple inheritance, constructor and destructor in inheritance, protected access, specifier, class conversions, multiple inheritance, multiple base classes, and virtual base classes. (12 Hrs)

Unit-V : Polymorphism**:** Virtual function, abstract base classes, Using polymorphism with example, Generic function, generic classes. (8Hrs)

Unit-VI : Stream in C++: Inserter, Extractor, Formatting, Manipulator, Error handling, user defined streams, defining Insertion and extractor operator. (10 Hrs)

TEXT BOOKS

1) Object oriented Programming with C++, Sahay, Oxford University Press
2) Programming with ANSI C++, Trivedi, Oxford University Press
3) Object Oriented Programming with C++ by E. Bal Guruswamy, Tata Mc-Graw Hill publishing Co.Ltd., New Delhi,1995.

REFFERENCE BOOKS:

1) Object Oriented Programming in Turbo C++ by Rober Lofore, Galgotia Publications Pvt..Ltd., New Delhi,1995
2) The C++ Programming Language by Bjarne Stroustrup Pub.Co.,New York, 1995 (Addison Wesley)
3) C++ Primer by Lipman Stanley B., New York, Addison Wesely Pub.Company, 1995
4) Data Structure using c and C++ by Langsam, Augenstein and Tenenbaum; PhI, New Delhi.
5) Joyce Farrell - Object Oriented Programming using C++, Cengage Learning Pub. Company

Link for MOOCS : https://onlinecourses.nptel.ac.in/noc22_cs103/preview

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1AE5 ELECTRIC AND MAGNETIC FIELDS

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Apply vector calculus to understand the behavior of static electric/magnetic fields.
2. Formulate and solve problems in electrostatics and magnetostatics in dielectric media.
3. Describe and analyze electromagnetic wave propagation in free-space.
4. Analyze plane electromagnetic waves at boundaries between homogeneous media.
5. Analyze the electromagnetic radiation from localized charges considering retardation effects
6. Apply the principles of electrostatics to the solutions of problems relating to electric field and electric potential, boundary conditions and electric energy density.

Unit-I Coordinate systems and Transformations**:** Scalars and vectors, unit vector, vector addition and subtraction, vector multiplication, components of a vector, orthogonal coordinate systems and their transformations, differential length, Area, and Volume, Del operator, Gradient, curl, divergent of a vector. (10 Hrs)

Unit-II Electrostatic: Coulomb's law and Electric field intensity, Electric flux density, Gauss's law, divergent theorem, Electric vector potential, Electric energy stored in static electric field, potential gradient. (10Hrs)

Unit-III Magneto static**:** current density and continuity equation, Biot-Savert's law, stokes theorem, Ampere's circuital law and applications, magnetic flux density, scalar and vector magnetic potential, Energy stored in static magnetic field, Maxwell equations for steady fields. (10 Hrs)

Unit-IV Maxwell equation and boundary conditions**:** Maxwell equation for time varying fields, Electric boundary conditionsfor conductor-dielectric interface, magnetic boundary condition for two different magnetic materials. (8Hrs)

Unit-V Electromagnetic waves**:** Electromagnetic wave equation in homogeneous medium, wave propagation in a perfect dielectric(free space), solution of electromagnetic wave equation, Intrinsic impedance, Poynting vectorand Poynting theorem, Reflection and Refraction of plane waves, Field analysis of transmission lines, characteristic impedance. (12Hrs)

Unit-VI Radiation: Retarded potential, Electric and magnetic fields due to oscillating dipole (Alternating current element),power radiated and radiation resistance, linear arrays, Endfire and broad side array, pattern multiplication. (10 Hrs)

TEXT BOOK:

1. Matthew N.O. Sadiku.: "Elements of Electromagnetic", Oxford University Press (FourthEdition,2008
2. Jordan E.C. and Balman K.C. : " Electromagnetic Waves and Radiating system" Prentice Hall of India Private Limited, (Second Edition), 1985.

REFFERENCE BOOKS:

1. Hayt W.H.: " Engineering Electromagnetics", Tata Mc-Graw Hill
2. Krauss J.D. : Electromagnetics", Mc-Graw Hill Books co.(Third Edition), 1984

Link for MOOCS: https://onlinecourses.nptel.ac.in/noc22_ee69/preview

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1AE6 ELECTRICAL ENGINEERING & NETWORK ANALYSIS LABORATORY

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Analyze and solve the Electric circuits
2. Understand different transformer connections
3. Compare different testing methods for Transformers
4. Apply the fundamental concepts in solving and analyzing different Electrical networks
5. Estimate the performance of a particular network from its analysis
6. Use relevant scientific instruments/apparatus and hardware/software tools

Minimum 10 experiments based on the syllabus of 1AE1, that are preferably uniformly distributed over the syllabus

List of Experiments;

After successful completion of the laboratory course, students would be able to demonstrate/perform/experiment/accomplish the listed activities.

List of the experiments include but not limited to the following. Concerned Teacher should design innovative experiments based on the syllabus with a view to develop standard laboratory and industrial skills/practices among students

1. To Analyse and Verify Kirchoff's Current Law in a parallel RLC circuit.
2. To Analyse and Verify Kirchoff's Voltage Law in a series RLC circuit
3. To compute Z-Parameters of a passive two port network
4. To compute Y-Parameters of a passive two port network
5. To compute ABCD parameter of a passive two port network
6. To Analyse and Verify Superposition Theorem in electric circuit
7. To Analyse and Verify Maximum Power Transfer Theorem in a network
8. To Analyse and Verify Thevenin Theorem in a network
9. To Analyse and Verify Norton's Theorem in a network
10. To Analyse and Verify Reciprocity Theorem in a network

Link for Virtual Lab: http://vlabs.iitb.ac.in/vlabs-dev/labs/network_lab/labs/explist.php

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1AE7 ELECTRONIC DEVICES AND CIRCUITS LABORATORY

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Experiment operation of various semiconductor devices and basic parameters
2. Implement basic circuits using electronic devices.
3. Verify and analyze performance of electronic circuits.
4. Design and test electronic circuit
5. Use relevant scientific instruments/apparatus and hardware/software tools

Minimum 10 experiments based on the syllabus of 1AE2, that are preferably uniformly distributed over the syllabus

List of Experiments:

After successful completion of the laboratory course, students would be able to demonstrate/perform/experiment/accomplish the listed activities. List of the experiments include but not limited to the following. Concerned Teacher should design innovative experiments based on the syllabus with a view to develop standard laboratory and industrial skills/practices among students

1. To plot forward and reverse transfer characteristics of P-N Junction diode.
2. To plot forward and reverse transfer characteristic of Zener diode.
3. To verify working of a Half wave rectifier and plot input/output waveforms
4. To verify working of a Full wave rectifier and plot input/output waveforms
5. To verify working of a Full wave bridge rectifier and plot input/output waveforms
6. To verify working of the series positive clipper and series negative clipper and also plot input/output waveforms
7. To verify working of a Positive and negative clamper circuit and plot input/output waveforms
8. To verify operation of Hartley Oscillator and plot input/output waveforms
9. To verify the operation of Colpitts Oscillator and plot input/output waveforms
10. To plot the transfer characteristics of JFET in Common Source Configuration and plot input/output waveforms
11. To plot the transfer Characteristics of PNP transistor in Common Emitter Configuration and plot input/output waveforms

Link for Virtual Lab : http://vlabs.iitkgp.ac.in/be/#

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1AE8 OBJECT ORIENTED PROGRAMMING C++ LABORATORY

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Justify the basics of object-oriented design and the concepts of encapsulation, abstraction, inheritance, and polymorphism
2. Design, implement, test, and debug simple programs in an object-oriented programming language.
3. Describe how the class mechanism supports encapsulation and information hiding.
4. Design and test the implementation of C++ programming concepts
5. Use relevant software tools/environment/platforms

Minimum 10 experiments based on the syllabus of 1AE3, that are preferably uniformly distributed over the syllabus

List of Experiments:

After successful completion of the laboratory course, students would be able to demonstrate/perform/experiment/accomplish the listed activities. List of the experiments include but not limited to the following. Concerned Teacher should design innovative experiments based on the syllabus with a view to develop standard laboratory and industrial skills/practices among students

1. Write a Program in C++ to use for statement to find factorial of number.
2. Write a Program in C++ to use class and object. Find area and circumference of circle.
3. Write a Program in C++ for array within a class.
4. Write a Program in C++ to use of parameterized constructor.
5. Write a Program in C++ to use of copy constructor.
6. Write a Program in C++ to use of friend function.
7. Write a Program in C++ to overload binary operator to add two complex number.
8. Write a Program in C++ to illustrate the use of single level inheritance.
9. Write a Program in C++ to illustrate the use of multiple inheritance.
10. Write a Program in C++ to demonstrate virtual base class.
11. Write a Program in C++ to show use of virtual function.

Link for Virtual Lab: http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/index.php

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1AE9 BASIC ELECTRONICS WORKSHOP (AEC-1)

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Identify, test and handle the basic electronics components
2. Understand the electronics components and their data sheets and characteristics.
3. Gain knowledge of fabrication technology for semiconductor devices and integrated circuits
4. Understand Function of PCB and PCB lay-out.
5. Test and Analyze the circuit and troubleshoot errors if any.
6. Classify the various types of Capacitors
7. Use relevant scientific instruments/apparatus and hardware/software tools

Minimum 10 Experiments will be based on the following.
List of the Experiments:

After successful completion of the laboratory course, students would be able to demonstrate/perform/experiment/accomplish the listed activities. List of the experiments include but not limited to the following. Concerned Teacher should design innovative experiments based on the syllabus with a view to develop standard laboratory and industrial skills/practices among students

1. Understanding transformers, Calculation of value of Resistor/Capacitor from its colour/bar code, Identification of Electronic passive components Resistors, Capacitors, inductors- types. Testing of these devices
2. Identification and Testing of devices - diode, Zener diode, Tunnel diode, LED, Silicon Controlled Rectifier, bipolar junction transistor, FET, MOSFET, etc.
3. Switches and relays- types, specifications, applications and testing.
4. Fuses, Cables and connectors - types, construction, specifications, testing and applications.
5.PCB layout design using any standard software package (ORCAD/PROTEL)

List of Experiment:

After successful completion of the laboratory course, students would be able to demonstrate/perform/experiment/accomplish the listed activities. List of the experiments include but not limited to the following. Concerned Teacher should design innovative experiments based on the syllabus with a view to develop standard laboratory and industrial skills/practices among students

1. To analyze and distinguish various type of fixed and variable resistors.
2. To identify and Analyse working of various fuses.
3. To identify and Analyse the Crystal
4. To identify and Analyse transformer and its various types and its working principles.
5. To identify and Analyse different types of cables and connectors.
6. To identify and Analyse different types of switches and relays.
7. To implement the process of fabrication of PCB.
8. To Measure amplitude, Time period and frequency of a sine wave and square wave using CRO.
9. To identify, analyze and distinguish various type of fixed and variable all types of capacitors
10. To Identify all active and passive electronic components in the given circuits.
11. To Study, analyse and use Function Generator/arbitrary waveform generator (Sine Wave, Square wave, Triangular Wave, pulse, etc.)
12. To identify and use the Various types of ICs, Crystals and Diodes.
13. To identify and use the Various types of Transistors. (NPN & PNP) Metal and Non Metal
14. To use the Bread board for fabrication of circuit
15. To Analyse Transformers
16. To Analyse and use Various Types of ICs and IC Bases
17. To Analyse ROM and RAM
18. To use Multimeters (Analog and Digital) Ammeter,Voltmeter,Micro Ammeter and Milliammeter
19. To demonstrate PCB Complete Etching Process
20. To use the Regulator ICs (Fixed and Variables Voltages with upto 2 Amp Current)

Link for virtual lab : http://vlabs.iitkgp.ac.in/be/#

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1AE10

#Internship/Field Work/Work Experience/Project

Student may complete their Internship/Field Work/Work Experience/Project in First OR Second OR Third Semester of M. Sc. (Applied Electronics) according to their convenience; @ denotes Non-Examination Credit

1AE 11 Open elective/ GIC/Open skill course/MOOC*

GIC 1 **Basics of Electronics** **(15)**

COs (Course Outcomes)

After successfully completing the course, the student will be able to

1. Understand the principle of Diode
2. Analyse diode circuits
3. Analyse working of LED

Unit-1: Diode theory and applications

Basic idea about forward bias, reverse bias and VI characteristics of PN junction diode, Zener diode, half wave rectifier, full wave rectifier, bridge rectifier, RC and LC filters, Design of un-regulated DC power supply, Introduction to fixed voltage regulators. Reading datasheet of semiconductor diode. (9)

Unit-2: LED and applications

LED working principle, Types of LED, Applications , LED lamp fabrication . (6)

Text Books:

1) Electronic Devices and : David A.Bell, Oxford University Press
2) Microelectronics : Millman and Halkias, TMGH

Reference Books:

1) Microelectronic Circuits : Sedra/Smith,5e,Oxford University Press
2) Electronic Devices & Circuit Theory : R. L. Boylestad & L. Nashlsky (6th Edition), Pearson Education

Link for MOOCS: https://nptel.ac.in/courses/117107095
https://nptel.ac.in/courses/108105060
http://vlabs.iitkgp.ernet.in/tcad/diode/index.html
http://vlabs.iitb.ac.in/vlab/electrical/exp12/index.html

SYLLABUS PRESCRIBED FOR TWO YEAR
P.G. DEGREE COURSE MASTER OF SCIENCE (APPLIED ELECTRONICS) SEMESTER PATTERN
SEMESTER: SECOND

2AE1 LINEAR INTEGRATED CIRCUITS

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Comprehend the knowledge of basic concepts and performance parameters of Op-Amp.
2. Analyze and design electronic circuits for various linear and non-linear applications
3. Explain the working of PLL, its applications and data converters.
4. Design voltage regulator circuits using ICS and discrete components.
5. Design Electronic circuits using different ICs and sensors.
6. Develop skills to design simple circuits using OP-AMP

Unit I : Operational Amplifier: Differential amplifier: gain expression using H parameters, transfer-characteristics, constant current source, level shifting, block diagram of op-amp, frequency response, frequency compensation methods, study of IC , measurement of parameters of op-amp, off set nulling and their importance. (10 Hrs)

Unit II : Linear Applications of Op-amp Inverting and non-inverting amplifiers, voltage followers (ACDC),integrator, differentiator, Differential amplifier, bridge amplifier, Instrumentation amplifiers, precision rectifier, RMS to DC converter, voltage to current converter, sinusoidal RC oscillators, constant voltage sources, frequency to voltage and voltage to frequency converter. (10 Hrs)

Unit III : Non-Linear Applications of Op-Amp and Filter Circuits Clipping and clamping circuits, comparator, astable, monostable and bistable multivibrator, Schmitt Trigger, voltage sweep generator, active filters: Butterworth, Chebyshev filters using op-amp, (10 Hrs)

Unit IV : Voltage Regulator Transistorized series and shunt voltage regulators, Block schematic of regulator IC 723, regulated power supply using IC 723, short circuit protection, switch mode power supply, dual tracking regulators, regulator using 78xx, 79xx, and LM 317. (10 Hrs)

Unit V : Timers: Block schematic of regulator IC 555, application of timer 555 as astable, monostable and bistable multivibrator, Delayed timer, sawtooth generators, function generator using 8038, Sample & Hold circuit (10 Hrs)

Unit VI : Phase Locked Loops Operation of phase lock loop system, transfer characteristics, lock range and capture range, study of PLL IC-LM 565 and its application as AM detector, FM detector and Frequency translator. (10 Hrs)

Text Books:

1) Gayakwad R.A. : Op-Amps and Linear Integrated Circuits, Prentice Hall of India Pvt. Ltd., New Delhi (2nd edition)
2) Robert F. Coughlin and F.F. Driscoll : Operational Amplifiers & Linear Integrated Circuits, Pearson Education

Reference Book:

Sedra/Smith : Microelectronics Circuits, 5e, Oxford University Press
Link for MOOCS: https://onlinecourses.nptel.ac.in/noc20_ee13/preview

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2AE2 MOBILE COMMUNICATIONS

COs (Course Outcomes)

After successfully completing the course the student would be able to

1. Understand various generations of mobile communications and the concept of wireless and cellular communications
2. Analyze the radio channel characteristics and the cellular principle
3. Analyze digital cellular mobile system
4. Know IS-95 CDMA mobile communication standard, its architecture, logical channels, advantages and limitations..
5. Analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling

Unit I: **Introduction to Wireless Communication System**
Evolution of mobile radio communications wireless System -1G, 2G, 2.5G and 3G, Mobile radio system around the world (AMPS, IS 95,GSM, N - AMPS), Applications of wireless communication systems - Paging System, Cordless telephone system, Cellular telephone system, Call processing in cellular telephone system. (10 Hrs)

Unit II: **The Cellular Concept**
Introduction to cellular system, Frequency reuse concept, Multiple Access Technologies for Cellular systems, Cellular system operation and Planning Principles, System Architecture, Hand off strategies, Interference and system capacity- Co channel interference & system capacity, Channel planning for wireless system, Adjacent channel Interference, Power control for reducing Interference, Improving coverage and capacity in cellular system, Cell splitting, Sectoring, Repeater for range extension, Micro cell zone concept. (12Hrs)

Unit III: **Digital Cellular Mobile System G.S.M.**
Concept of GSM, GSM Standard, features, service aspects, GSM System Architecture, GSM Radio subsystem, air interface specifications, channel types, frame structure, signal processing. (8Hrs)

Unit IV: **CDMA System (IS-95)**
CDMA Digital Cellular standard, Frequency and channel specifications, CDMA System architecture, features of IS-95, comparison of GSM and IS-95 System (10 Hrs)

Unit V: **Modern Wireless Communication System**
Third Generation (3G) Wireless Networks advantages, 3G W-CDMA (UMTS) (Universal mobile Telecommunication system.), features, 3G CDMA 2000, 3G- TD-SCDMA (synchronous), Wireless local loop , advantages, applications, LMDS (local multipoint distribution), Features of Bluetooth. (10 Hrs)

****(No need of detail mathematical calculation, derivations, numerical for this subject)**

TEXT BOOKS:

1) William CY Lee: "Mobile Cellular Telecommunications"(Second Edition) McGraw Hill Inc. (1995)
2) Theodore S. Rappaport: Wireless Communications: Principles & Practice 2nd Edition, Pearson education

Link for MOOCS: https://onlinecourses.nptel.ac.in/noc20_ee61/preview

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2AE3 AEC-2 on DSC-7

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Draw functional block diagram, explain operations and analyze the mobile unit and understand mobile communication

Unit 1: **Mobile Unit**

Block diagram and operation of mobile Unit, Block Diagram and operation of frequency synthesizer, transmitter, Receiver, Logic Unit and Control unit, Essential features of hand set, Definition of mobile base station, Mobile control station. (10 Hrs)

TEXT BOOKS:

1) William CY Lee: "Mobile Cellular Telecommunications"(second Edition) McGraw Hill Inc. (1995)
2) Theodore S. Rappaport: Wireless Communications: Principles & Practice 2nd Edition, Pearson education

Link for MOOCS: https://onlinecourses.nptel.ac.in/noc20_ee61/preview

2AE4 DIGITAL INTEGRATED CIRCUITS

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Solve logic functions using Boolean Algebra , number systems and its conversion.
2. Analyse Digital logic families and the operation of various flip-flops, counters and shift registers
3. Identify, analyze and design combinational circuits like the encoder, decoder, multiplexer, demultiplexer, adder.
4. Analyse programmable logic devices and Construct digital design using PLDs.
5. Classify and Explain semiconductor memories
6. Analyze, design and implement sequential logic circuits.

Unit I : Number systems, Gray codes, Arithmetic operations, 2's complements, floating point arithmetic and its representation,Logic gates, Boolean algebra, standard form of logical function, K-map up to five variables, Quine Mc-Cluskey method,Don't care conditions and their effects, Synthesis using AND- OR gates (10 Hrs)

Unit II : Study and analysis of digital logic families: TTL, ECL, MOS, CMOS and their characteristics, Tri-state logic, TTL and CMOS IC series , Latches, Flip-Flops R-S, J-K, Master slave J-K, D-type, T-type, registers and counters, Adders and subtractors using logic gates. (10 Hrs)

Unit III : Combinational Logic Design using 74/54 MSI chip series concerning to multiplexers, De-multiplexers, decoders, encoders, comparators, code converters, priority encoders, parity generator/ checker & BCD-to-seven segment decoder. (10 Hrs)

Unit IV : Combinational Logic Design using ROM array, PLA, PAL, Preliminary design concepts using FPGAs, N-bit binary adder using 7480. carry Look ahead adder construction. (10 Hrs)

Unit V : Types of semiconductor memories, sequential memories, 2 and 4 phase ratio- less shift registers, CMOS registers stages, static shift registers, implementation of ROM (ROM, PROM, EPROM, EEPROM) BJT RAM cell, MOS-RAM,CCD memories. (10 Hrs)

Unit VI : Design of sequential networks: Analysis of clocked sequential networks, General models of sequential machines, 13 14 Equivalence and minimization networks, Deviation or state graph and tables, reduction of state assignments, S.M. chart. (10 Hrs)

Text Books:

1) M. Mano. : Digital Design 3rd ed (Pearson Education)
2) R.P. Jain : Modern Digital Electronics 3rd ed (TMH)
3) Ken Martin : Digital Integrated Circuit Design, Oxford University Press

Reference Book:

1) Sedra/Smith : Microelectronics Circuits, 5e, Oxford University Press

Link for MOOCS: https://onlinecourses.nptel.ac.in/noc22_ee110/preview

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2AE5 MICROPROCESSOR AND MICROCONTROLLER

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Compare architectural difference between Microprocessor and Microcontroller.
2. Apply knowledge and demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microprocessor and microcontroller
3. Distinguish and analyze the properties of Microprocessors & Microcontrollers
4. Analyze the data transfer information through serial & parallel ports
5. Design electrical circuitry to the Microprocessor I/O ports in order to interface the processor to external devices.
6. Evaluate assembly language programs and download the machine code that will provide solutions real-world control problems.

Unit I : An introduction to 8085: Address decoding technique, 8085 architecture, Register structure,, memory addressing and addressing modes. Instruction set of 8085 microprocessors. Interrupt system of 8085. (10 Hrs)

Unit II : An introduction to 8051 : Overview of the 8051 family, Architecture of 8051, Signal description of 8051, Internal Memory, Internal RAM, External Memory, Register structure, stack and stack pointer, SFR, I/O port structure, Timer structure and their modes. serial data input and output, serial data transmission and reception. (10 Hrs)

Unit III : Instruction set of 8051, Addressing modes of 8051, Data moves, PUSH, POP, and Data exchange instruction, Logical bit and Byte level operation, Arithmetic operation ,Jump and Call instruction, time delay generation and calculation , Interrupts and returns , programming using 8051, Timer / counter programming, serial communication programming & Interrupt programming. (10 Hrs)

Unit IV : Architecture, modes, and programming of PPI 8255, DMA data transfer concepts. Internal architecture, interfacing of 8255 with 8051 & Programming. (10 Hrs)

Unit V : Analog to digital and digital to analog conversion techniques and its interfacing with 8085: Case study of ADC0800V and ADC1210, Case study of DAC 0808 and DAC 1008/8051. Interfacing of Analog to Digital Converter, digital to analog converter. Application of DAC for generating different waveforms. (10 Hrs)

Unit VI : 8051 interfacing to external memory, Interfacing LCD & stepper motor with 8051, interfacing of seven segment display to 8051 and programming. Interfacing of keyboard to 8051. (10 Hrs)

TEXTBOOKS:

1) Han-Way Huang, Using the MCS-51 Microcontroller, Oxford University Press
2) K. J. Ayala: "The 8051 Microcontroller", Penram Int. Pubs., 1996
3) Mazidi & Mazidi: "8051 Micro-controller & Embedded System", Pearson Edu., 2nd Edition.
4) Rajkamal: Architecture Programming, Interfacing & System design. Pearson Edu.

REFERENCE BOOKS :

1) A. K. Ray and K. M. Bhurchandi : Advanced Microprocessor and Peripherals, Architecture Programming and Interfacing, Tata McGrawHill Publishing Co. Ltd., New Delhi (TMH)

Link for MOOCS: https://onlinecourses.nptel.ac.in/noc22_ee12/preview

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2AE6x PROFESSIONAL ELECTIVE # 1

2AE61 ELECTRONIC INSTRUMENTATION

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Identify various sensors, transducers and their brief performance specifications.
2. Classify various errors present in measuring instruments.
3. Analyze the performance characteristics of each instrument
4. Understand working principle of various transducers used to measure Temperature, Displacement, Level, Pressure, Strain etc.
5. Compare various transducers and understand their applications in industry.
6. Explain Data Acquisition System

Unit I : Transducer & Instrumentation systems :Transducer classification: Active/Passive. Primary/Secondary. Analog/Digital and transduction Principles. Basic Signal conditioning Circuits. Resistive/Capacitive/Inductive reactance bridge. Current/Voltage Sensitive Wheatstone bridges & Generalized instrumentation system with particular examples (10Hrs)

Unit II : Static characteristics, errors & statistical parameters: Static characteristics: Accuracy, Precision, Sensitivity, Threshold, Resolution, Repeatability and Hysteresis. Errors: Gross error, Systematic error, Random error, Limiting error. Statistical Parameters: Arithmetic mean Average deviation Standard deviation. Probable error, Histogram, Normal & Gaussian curve of errors. (10 Hrs)

Unit III : Electronics Instrumentation: Analog & Digital data acquisition system, Analog electronic multimeter, Introduction to digital voltmeter & universal counter. Strip chart & X-Y recorders. Optical Encoders. Seismic mass vibration transducer. (3)Introduction to microphones & loud speaker. (10 Hrs.)

Unit IV : Measurement of Temperature & Strain Temperature Sensors: LM335, RTD. THERMISTORS, Thermocouples, Thermocouples laws & its compensation, methods. Pyrometers: Total/Partial radiation & optical pyrometers. Strain Gauges, Gauge factor. Strain measurement & temperature compensation methods. (10Hrs)

Unit V : Measurement of Displacement. Pressure & Level. Displacement Measurement: using resistive, capacitive, inductive (LVDT & RVDT) & Eddy current. Pressure Measurement: Elastic, Inductive, Piezoelectric & capacitive transducers, Low pressure measurement using ionization gauge, pirani gauge, thermocouple vacuum gauge. Level Measurement: Using ultrasonic, capacitive, inductive, resistive with float, gamma rays & eddy currents techniques. (10 Hrs.)

Unit VI : Measurement of Flow, Humidity, Velocity . Flow Measurement: using ultrasonic, electro aquatic & hotwire Anemometer. Humidity Measurement : using resistive, Capacitive & Crystal transducers. Velocity Measurement: Using photo detectors (both linear & angular velocity). Introductory block diagram of smart sensors, Wave analyzer & spectrum analyzers. (10 Hrs.)

Text Books:

1) Sawhney A.K.: A course in Electrical/Electronic Measurement & Instrumentation, Dhanpat Rai & Sons., Delhi.
2) Rangan C.S., Sharma G.R. , & Mani V.S.V.: Instrumentation Devices & System, Tata Mc- Graw Hill.
3) W.D. Cooper, Electronic Instrumentation And Measurement Techniques , Prentice-Hall

Reference Books:

1) Patranbis D. : ' Sensors & Transducers', A. H. Wheeler & Company, Prayag, India.
2) H. S. Kalsi : Electronics Instrumentation, Tata McGraw Hill, 2nd Edition
3) U.A. Bakshi & A. V. Bakshi : Electronics Instrumentation, Technical Publication
4) Electronic Test Instruments: Analog and Digital Measurements, Robert A. Witte, Pearson, 2 edition

Link for MOOCS: https://onlinecourses.nptel.ac.in/noc19_ee44/preview

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2AE6x PROFESSIONAL ELECTIVE # 2
2AE62 CONTROL SYSTEMS

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Analyze feedback control systems in continuous- and discrete time domains.
2. Analyse transient response and steady state response parameters.
3. Analyze stability/relative stability of the LTI system.
4. Develop and analyze state space models
5. Analyze the response of the discrete time system.
6. Formulate different types of analysis in frequency domain to explain the nature of stability of the system

Unit I : Basic definitions, Closed and open loop systems, transfer functions, block diagrams, Derivation of transfer functions (only electrical systems), signal flow graphs, basic control action. (10 Hrs.)

Unit II : Time response Analysis, Impulse response function, Analysis of first, second and higher order system, stability of control system, Routh Hurwitz's stability criterion, static and dynamic errors coefficients, error criteria (10 Hrs.)

Unit III : Root locus method, introduction, root locus plots, rules for constructing root loci, Root locus analysis of control systems, effect of zeros, derivative control and velocity feedback. (10 Hrs.)

Unit IV : Frequency response, Bode Plots, Determination of static Position, Velocity and acceleration error coefficients. Polar plots, Nyquist stability criterion, stability analysis, relative stability. (10 Hrs.)

Unit V : State space representation of systems, solutions of state equations, transition matrix, diagonalisation, controllability and observability. (10 Hrs.)

Unit VI : Sampled data control system; Introduction, difference equations, Z-transform and properties, Inverse Z-transforms. Analysis of sampler and Zero-order hold, transfer function of sampled data systems (Block diagrams) (10 Hrs.)

TEXT BOOKS:

1) I.J. Nagrath & M. Gopal (3/e) : Control systems Engineering (WEL)
2) Stefani, Shahian, Savant, Hostetter : Design of Feedback Control Systems, 4e, Oxford University Press
3) B.C. Kuo (7/e): Automatic Control Systems (PHI)
4) Ogata : Modern Control Engineering (PHI)

Link for MOOCS: https://nptel.ac.in/courses/108102043

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2AE6x PROFESSIONAL ELECTIVE # 2
2AE63 INTRODUCTION TO DATA SCIENCE AND NEURAL NETWORKS

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Understand core concepts of data science
2. Collect and manage data
3. Analyse data
4. Visualize data
5. Apply MLP neural networks for classification and recognition problems.
6. Design, train and test FFNNs for classification problems

Unit 1

Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications, Mathematical Foundations for Data Science, Introduction to Statistical Methods: basic and some advanced concepts of probability and statistics; Concepts of statistics in solving problems arising in data science. (10Hrs)

Unit 2

Data collection and management: Introduction, Sources of data, Data collection and APIs, Exploring andfixing data, Data storage and management, using multiple data sources (10Hrs)

Unit 3

Data analysis: Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes. (10Hrs)

Unit 4

Data visualization: Introduction, Types of data visualization, Data for visualization: Data types, Data encodings, Retinal variables, mapping variables to encodings, Visual encodings. (10Hrs)

Unit 5

Neural Network, Models of a neuron, Network architectures, knowledge representation, learning processes, Basics of artificial neural networks (ANN), Artificial neurons, Computational models of neurons, Structure of neural networks, Perceptron, Multilayer Perceptrons, Backpropagation Algorithm, Functional units of ANN for pattern recognition tasks (10Hrs)

Unit 6

Feedforward neural networks, Regression and classification, Pattern classification using Multilayer feedforward neural networks (FFNNs), Convolutional Neural Networks, Kernel methods and Radial Basis Function Networks, Regularization, Autoencoders (10Hrs)

Textbooks:

1. Cathy O'Neil, Rachel Schutt, Doing Data Science, Straight Talk from The Frontline. O'Reilly,2013.
2. Introducing Data Science, Davy Cielen, Arno D. B. Meysman, Mohamed Ali, Manning Publications Co., 1st edition, 2016
3. An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten,Trevor Hastie, Robert Tibshirani, Springer, 1st edition, 2013
4. Simon Haykin, Neural Networks and Learning Machines , Prentice Hall of India, 2010

References:

1. Jure Leskovek, Anand Rajaraman, Jeffrey Ullman, Mining of Massive Datasets. v2.1, CambridgeUniversity Press, 2014.
2. Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly, 1st edition, 2015.
3. Doing Data Science, Straight Talk from the Frontline, Cathy O'Neil, Rachel Schutt, O' Reilly, 1stedition, 2013.
4. Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, CambridgeUniversity Press, 2nd edition, 2014.
5. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep learning, In preparation for MIT Press, Available online: http://www.deeplearningbook.org, 2016
6. Satish Kumar, Neural Networks - A Class Room Approach, Second Edition, Tata McGraw-Hill, 2013
7. C.M. Bishop, Pattern Recognition and Machine Learning, Springer, 2010

Link for MOOCS: https://onlinecourses-archive.nptel.ac.in/noc17_mg24/preview

2AE7 INTEGRATED CIRCUITS LABORATORY

COs (Course Outcomes)

After successfully completing the course the student would be able to

1. Design various linear and nonlinear applications by using IC 741.
2. Design voltage regulators using discrete components and ICs.
3. Implement various waveform generators using IC555, IC565, IC566, IC8038
4. Apply practically the concepts of digital electronics.
5. Understand the operation of various logic gates and their implementation using digital IC's.
6. Design and implement various combinational logic circuits and sequential logic circuits.
7. Use relevant scientific instruments/apparatus and hardware/software tools

Minimum 10 experiments based on the syllabi of 2AE1: Linear Integrated Circuits and 2AE3: Digital Integrated Circuits, that are preferably uniformly distributed over the syllabi.

List of Experiment:

After successful completion of the laboratory course, students would be able to demonstrate/perform/experiment/accomplish the listed activities.
List of the experiments include but not limited to the following. Concerned Teacher should design innovative experiments based on the syllabus with a view to develop standard laboratory and industrial skills/practices among students

1. To Analyse and Verify operation of Adder & Subtractor.
2. To Analyse and Verify operation of Encoder & Decoder.
3. To Analyse and Verify operation of Multiplexer & De-multiplexer
4. To Analyse and Verify operation of 4-Bit SISO Shift Register.
   To Analyse and Verify operation of 4-Bit SIPO Shift Register.
   To Analyse and Verify operation of 4-Bit PISO Shift Register.
   To Analyse and Verify operation of 4-Bit PIPO Shift Register.
5. To Analyse and Verify operation of SR,JK,D,T Flip-flop.
6. To Design basic gates from Universal gates.
7. To Analyse and verify operation of De' Morgan's theorem.
8. To Analyse and verify operation of an Inverting Amplifier.
9. To Analyse and verify operation of a Non-Inverting Amplifier.
10. To Analyse and verify operation of an Integrator using OPAMP
11. To Analyse and verify operation of a Differentiator using OPAMP
12. To Analyse and verify operation of a Voltage Follower.
13. To Analyse and verify operation of a BCD to 7-Segment Decoder.
14. To Analyse and verify operation of a Wein Bridge Oscillator.
15. To design NOT, OR, AND gate using NAND gate and NOR gate.
16. To Analyse and Verify the truth table of 4:1 multiplexers and
    1:4 de multiplexers
17. To Analyse and verify the truth table of 8 to 3 line encoder and 3 to 8 line decode

Link for Virtual Lab: https://da-iitb.vlabs.ac.in/List%20of%20experiments.html
https://ae-iitr.vlabs.ac.in/List%20of%20experiments.html
http://he-coep.vlabs.ac.in/List%20of%20experiments.html
https://dld-iitb.vlabs.ac.in/List%20of%20experiments.htm

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2AE8x PROFESSIONAL ELECTIVE LABORATORY

Minimum 10 experiments each based on the syllabus of subjects included in 2AE6x, that are preferably uniformly distributed over the syllabus. A student, after choosing anyone of the following subjects, has to conduct minimum 10experiments based on the syllabus. Professional Elective group is comprised of the following subjects.
2AE61: Electronic Instrumentation , 2AE62: Control Systems and , 2AE63: Introduction to Data Science and Neural Networks

2AE81 ELECTRONIC INSTRUMENTATION LABORATORY

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Correlate theoretical principles with practical issues of electronic instrumentation
2. Get exposed to a set of multidisciplinary aspects, both theoretical and practical, providing them with the ability of integrating blocks in which they have practically worked into a full instrumentation system.

3. Use relevant scientific instruments/apparatus and hardware/software tools

Minimum 10 experiments each based on the syllabus of 2AE51: Electronic Instrumentation, that are preferably uniformly distributed over the syllabus.

List of Experiments:
After successful completion of the laboratory course, students would be able to demonstrate/perform/experiment/accomplish the listed activities.
List of the experiments include but not limited to the following. Concerned Teacher should design innovative experiments based on the syllabus with a view to develop standard laboratory and industrial skills/practices among students

1. Measurement of phase difference & frequency using CRO (Lissajous Figure)
2 To measure unknown capacitance using Wein's frequency bridge.
3. Analyse the characteristics of Strain Gauge and measurement of strain
4. Analyse the characteristics of linear variable differential transformer (LVDT) and Measure displacement using LVDT.
5 Plot Characteristics of LDR, Photo-Diode, and Phototransistor
6.To plot characteristics of temperature Transducer like thermocouple, thermistor
7. Analysis of distance measurement using ultrasonic
8. Analysis of L.C.R. and determination of the value of the given components.
9.To analyse blockwise construction of an analog Oscilloscope & function generator.
10.To measure flow by using a suitable transducer
Link for Virtual Lab : http://vlabs.iitb.ac.in/vlab/labsextc.html
http://vlabs.iitkgp.ernet.in/asnm/#

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2AE82 CONTROL SYSTEMS LABORATORY

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Model dynamical systems and the characteristics of control components like ac servo motor, synchro and magnetic amplifier.
2. Simulate and analyze the stability using MATLAB software and design the compensators.
3. Analyze the physical systems represented in transfer function.
4. Apply the control components like ac servo motor, synchro and magnetic amplifier.
5. Design controllers, compensators using MATLAB software
6. Use relevant software tools/platforms/environment

Minimum 10 experiments each based on the syllabus of 2AE62: Control Systems, that are preferably uniformly distributed over the syllabus.

List of Experiment:
After successful completion of the laboratory course, students would be able to demonstrate/perform/experiment/accomplish the listed activities.
List of the experiments include but not limited to the following. Concerned Teacher should design innovative experiments based on the syllabus with a view to develop standard laboratory and industrial skills/practices among students

1. Generation of Unit Step Signal.
2. Generation of Exponential Signal
3. To plot pole zero map following transfer function.
4. To plot the step response of a given transfer function.
5. To plot an impulse response of given system.
6. To plot the step response with dc gain of transfer function.
7. To compute and plot the root locus of given transfer function.
8. To plot Bode plot with zero order system Transfer function.
9. To compute and plot Bode plot with first order system Transfer function.
10. To compute the partial fractions of Z-transform.
11. To compute and plot the region of convergences of a given z-plane.
12. To compute Partial fraction expansion and Transform function: Transfer Function.
13. To compute Z transforms of a given function.
14. To compute inverse z- transform of a given function.
15. To compute inverse z transform of a given function.
16. To determine the system is controllable or not.
17. To determine the system observable or not
18. To compute the Eigen value of given matrix.
19. To compute the various matrix operation.
Link for Virtual lab http://vlabs.iitb.ac.in/vlabs-dev/labs/network_lab/labs/explist.php

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2AE83 INTRODUCTION TO DATA SCIENCE AND NEURAL NETWORK LABORATORY

COs (Course Outcomes)

After successfully completing the course, the student would be able to

1. Implement and test common learning algorithms
2. Design, implement, train and debug single and multi-layer feed-forward neural networks
3. Apply neural networks to classification and recognition problems.
4. Use relevant software tools/platforms/environment

Minimum 10 experiments each based on the syllabus of 2AE53: Introduction to Data Science and Neural Network, that are preferably uniformly distributed over the syllabus.

LIST OF EXPERIMENTS
After successful completion of the laboratory course, students would be able to demonstrate/perform/experiment/accomplish the listed activities.
List of the experiments include but not limited to the following. Concerned Teacher should design innovative experiments based on the syllabus with a

view to develop standard laboratory and industrial skills/practices among students

1. Write a program in Matlab to plot 1-D, 2-D and 3-D data
2. Write a program in Matlab to compute statistical parameters of data
3. Write a program in Matlab to draw multiple scatter plots in the 2-D feature space of the N-dimensional data
4. Write a program in Matlab to plot multiple curves in single plot by creating a script file
5. Write a program in Matlab for plotting multiple curves in single figure
6. Write a program in Matlab to plot Activation function used in neural network
7. Write a program in Matlab to plot piecewise continuous activation function (threshold and signum function in neural network)
8. To realize gates using McCulloch Pitts model in Matlab
9. Write a program to implement XOR gate using McCulloch Pitts neuron
10. Write a program to create the Perceptron using GUI in Matlab
11. Write a program in Matlab to create Perceptron using commands
12. Write a program in Matlab to classify the Classes using Perceptron
13. Write a program to illustrate how the perception learning rule works for non-linearly separable problems
14. Write a program to illustrate Linearly non-separable vectors
15. Write a program in Matlab for Pattern Classification using Perceptron network
16. Write a program in Matlab for creating a Back Propagation Feed-forward neural network
17. Write a program in Matlab to design, implement and test multilayer FFNN for pattern classification problems
18. To design and test RBF Network for regression problem

Link for Virtual lab : http://cse22-iiith.vlabs.ac.in/List%20of%20experiments.html

2AE9 MICROPROCESSOR AND MICROCONTROLLER LABORATORY

COs (Course Outcomes)

After successfully completing the course, the students would be able to

1. Develop skill of writing programs in ALP for various applications of 8085 & 8051.
2. Interface various peripherals with 8085 & 8051.
3. Use relevant scientific instruments/apparatus and hardware/software tools

Minimum 10 experiments based on the syllabus of 2AE4, that are preferably uniformly distributed over the syllabus.
List of Experiments:

After successful completion of the laboratory course, students would be able to demonstrate/perform/experiment/accomplish the listed activities.
List of the experiments include but not limited to the following. Concerned Teacher should design innovative experiments based on the syllabus with a view to develop standard laboratory and industrial skills/practices among students

1. To analyze internal architecture of 8085 Microprocessor
2. To write a program for addition of two 16-bit numbers and for subtraction of two 8-bit numbers.
3. To write a program for multiplication of two 8-bit numbers.
4. To interface LED to 8085 using 8255.
5. To interface stepper motor with 8085 microprocessor.
6. To interface 8-bit ADC with microprocessor 8085.
7. To write a program in microcontroller to demonstrate
   (a) Addition of 8 bit
   (b) Subtraction of 8-bit
8. To Write a program to microcontroller to demonstrate
   (a) Multiplication of 8 bit
   (b) Division of 8 bit
9. To write a program in Microcontroller to demonstrate
   (a) Swap
   (b) 1's complement
   (c) 2's Complement
10. To write a program in Microcontroller to demonstrate block of data filling
11. To interface 8-bit DAC with microprocessor 8085

Link for Virtual lab: http://vlabs.iitb.ac.in/vlabs-dev/labs/8051-Microcontroller-Lab/labs/index.php
http://vlabs.iitb.ac.in/vlabs-dev/labs_local/microprocessor/labs/explist.php

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2AE10 #Internship/Field Work/Work Experience/Project

Students may complete their Internship/Field Work/Work Experience/Project in First OR Second OR Third Semester of M. Sc. (Applied Electronics) according to their convenience; @ denotes Non-Examination Credit

2AE 11 Open elective/ GIC/Open skill course/MOOC*

GIC 2 **Fundamentals of IoT** **(15)**

After successfully completing the course, the student will be able to

1. Understand framework of Internet of things
2. Write Arduino programs

Unit-1: Introduction to Internet of Things, Characteristics of IoT, Physical design of IoT, Functional blocks of IoT, Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks. (9)

Unit-2: Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, (6)

TEXT BOOKS

1. The Internet of Things: Enabling Technologies, Platforms, and Use Cases, by Pethuru Raj and Anupama C. Raman (CRC Press)

2. Make sensors: Terokarvinen, kemo, karvinen and villey valtokari, 1st Ed., Maker Media, 2014.
3. Introduction to IoT. S. Misra, A. Mukherjee, and A. Roy, Cambridge University Press. 2020 Availability: https://www.amazon.in/Introduction-IoT-Sudip Misra/dp/1108959741/ref=sr_1_1?dchild=1&keywords=sudip+misra&qid=1627359928&sr=8-1
4. Introduction to Industrial Internet of Things and Industry 4.0. S. Misra, C. Roy, and A. Mukherjee, 2020. CRC Press. Availability: https://www.amazon.in/dp/1032146753/ref=sr_1_3

REFERENCES

1. Internet of Things: A Hands-on Approach, by Arshdeep Bahga and Vijay Madisetti.
2. Beginning Sensor networks with Arduino and Raspberry Pi – Charles Bell, Apress, 2013

Link for MOOCS: https://archive.nptel.ac.in/courses/106/105/106105166/
https://iotify.help/virtual-lab/hello-iot/ibm.html

GUIDELINES FOR EVALUATION OF STUDENTS AND PAPER SETTERS

1. Medium of Instructions and examination shall be ENGLISH.
2. For the internal assessment & University end semester theory examinations, the paper should be set preferably from the question bank prepared by the university.

The question should be based on bloom's Taxonomy levels of (a) Remembering (b) Understanding (c) Application (d) Analysis.

Remember: -

Skill Demonstrated	**Question Ques / Verbs for tests**
• Ability to recall of information like, facts, conventions, definitions, jargon, technical terms, classifications, categories, and criteria ability to recall methodology and procedures, abstractions, principles and theories in the field • Knowledge of dates, events, places. • Mastery of subject matter	List, define, describe, state, recite, recall, identify, show, label, tabulate, quote, name, who, when where, etc.

Understand: -

Skill Demonstrated	**Question Ques / Verbs for test**
• Understanding information grasp • meaning • translate knowledge into new context • interpret facts, compare, contrast order, • group, infer causes predict consequences •	Describe, explain, paraphrase, restate, associate, contrast, summarize, differentiate interpret, discuss.

Apply: -

Skill Demonstrated	**Question Ques / Verbs for test**
•• Use information use methods, concepts, laws, theories in new • situations solve problems using required skills of knowledge • Demonstrating correct usage of method or procedure	Calculate, predict, apply, solve, illustrate, use, demonstrate, determine, model, experiment, show, examine, modify.

Analysis: -

Skill Demonstrated	**Question Ques / Verbs for test**
• break down a complex problem into parts. Identify the relationships and interaction • between the different parts of complex problem.	Classify, outline, break down, categorize, analyse, diagram, illustrate, infer, select.

Evaluation (Judging)

Skill Demonstrated	**Question Ques / Verbs for test**
Evaluation questions encourage students to develop opinions and make value decisions about issues based on specific criteria	. Assess, Critique, Determine, Evaluate, Judge, Justify, Measure & Recommend **Examples of questions:** • "How could you select...?" • "How could you prove...?" • "How would you prioritize...?" • "What information would you use to support...?"

Synthesis (Creating)

Skill Demonstrated	Question Ques / Verbs for test
These questions encourage students create something new by using a combination of ideas from different sources to form a new whole	Arrange, Combine, Create, Design, Develop Formulate, Integrate & Organize Examples of questions: "What could be changed to improve...?" "How would you test...?" "What way would you design...?" "What outcome would you predict for...?"

The Weightage of marks should be given preferably in the range of :

(a)	Remembering	10 to 20%
(b)	Understanding	30 to 45%
(c)	Application	30 to 45%
(d)	Analysis	10 to 20%
(e)	Evaluation (Judging)	10 to 15%
(f)	Synthesis (Creating)	10 to 15%
		---
		100 to 160%

Types of Questions: -

a) Multiple Choice Question (M.C.Q.) as an when applicable: -

1. **Relevant content:** The question should be based on the relevant and important content.
2. **Application of knowledge, not only theory:** The question tests the application of knowledge, does not only test how the candidate recalls isolated theoretical facts.
3. **Focused questions and homogeneous answers:** The question focuses on one relevant aspect of the topic, all proposed answers belong to the same content dimension (i.e., diagnosis, or causes, or managements decisions etc.)
4. **Clear and unambiguous answer:** The best answer clearly stands out. Avoid "correct" answers with existing controversial doctrines.
5. **Appropriate level of difficulty (50% -90% correct answers):**

   Too difficult - even the best candidates need to guess
   Too easy - weak candidates get a "present"
6. **Unambiguous, concise and simple phrasing:** Avoid trick questions, double negatives.

   Use only common abbreviations, short sentences etc.
   Avoid imprecise qualifications (often, usually etc
7. **Avoid clues:**

   Clues can help candidates guess the correct answer. Examples are:

- One answer is much more detailed than the others
- Only one answer follows grammatically from the stem •Non logical order of the answers

General strategies

- **Test comprehension and critical thinking, not just recall**
  Ask MCQ so as to interpret facts, evaluate situations, explain cause and effect, make inferences, and predict results.
- **Use simple sentence structure and precise wording**
  Write test questions in a simple structure that is easy to understand. And try to be as accurate as possible in your word choices. Words can have many meanings depending on colloquial usage and context.
- **Use familiar language.**
  The question should use the same terminology that was used in the course. Avoid using unfamiliar expressions or foreign language terms, unless measuring knowledge of such language is one of the goals of the question. Students are likely to dismiss distracters with unfamiliar terms as incorrect.

- **Place most of the words in the question stem**
  While using a question stem, rather than an entire question, ensure that most of the words are in the stem. This way, the answer options can be short, making them less confusing and more legible.
- **Avoid giving verbal association clues from the stem in the key.**
  If the key uses words that are very similar to words found in the stem, students are more likely to pick it as the correct answer.
- **Avoid trick questions**
  Questions should be designed so that students who know the material can find the correct answer. Questions designed to lead students to an incorrect answer, through misleading phrasing or by emphasizing an otherwise unimportant detail of the solution, violate this principle.
- **Avoid negative wording**
  Students often fail to observe negative wording and it can confuse them. As a result, students who are familiar with the material often make mistakes on negatively worded questions. In general, avoid having any negatives in the stem or the options. In the rare cases where you use negatives be sure to emphasize the key words by putting them in upper case, and bolding or underlining them.
- **Avoid double negatives**
  Don't use combinations of the words like not, no, nor, the -un prefix, etc in the same question.
- **Make the choices grammatically consistent with the stem.**
  Read the stem and each of the choices aloud to make sure that they are grammatically correct.
- **As far as possible, keep all answer choices of the same length.**
  This can be difficult to achieve, but expert test-takers can use answer length as a hint to the correct answer. Often the longest answer is the correct one. When one can't get all four answers to the same length, two short and two long can be used.
- **Place the choices in some meaningful order.**
  When possible, place the choices in numerical, chronological or conceptual order. A better structured question is easier to read and respond.
- **Randomly distribute the correct response.**
- The exam should have roughly the same number of correct answers that are a's, b's, c's and d's (assuming there are four choices per question)
- **Avoid using "all of the above"**
  If "all of the above " is an option and students know two of the options are correct, the answer must be "all of the above". If they know one is incorrect, the answer must not be "all of the above". A student may also read the first option, determine that it is correct, and be misled into choosing it without reading all of the options.
- **Avoid using "none of the above"**
  The option "none of the above" does not test whether the student knows the correct answer, but only that he/she knows the distracters aren't correct.
- **Refrain from using words such as always, never, all, or none.**
  Most students know that few things are universally true or false, so distracters with these words in them can often be easily dismissed.
- **Avoid overlapping choices**
  Make the alternatives mutually exclusive. It should never be the case that if one of the distracters is true, another distractor must be true as well.
- **Avoid questions of the form "Which of the following statements is correct?"**
  There is no clear question being asked, and the choices are often heterogeneous. Such questions are better presented in the form of True/ False questions.
- **Instruct students to select the "best answer" rather than the "correct answer"**
  By doing this, you acknowledge the fact that the distracters may have an element of truth to them and discourage arguments from students who may argue that their answer is correct as well.

Designing stems

- **Express the full problem in the stem.**

When creating the item, ask yourself if the students would be able to answer the question without looking at the options. This makes the purpose of the question clear.

- **Put all relevant material in the stem.**
  Do not repeat in each of the alternatives information that can be included in the stem. This makes options easier to read and understand, and makes it easier for students to answer the question quickly.
- **Eliminate excessive wording and irrelevant information from the stem.**
  Irrelevant information in the stem confuses students and leads them to waste time.

Designing alternatives

- **Limit the number of alternatives.**
  Use between three and five alternatives per question. Research shows that three choice items are about as effective as

four or five-choice items, mainly because it is difficult to come up with plausible distracters.

- **Make sure there is only one best answer.**

  Avoid having two or more options that are correct, but where one is "more" correct than the others. The distracters should be incorrect answers to the question posed in the stem.
  Make the distracters appealing and plausible.

  All of the wrong answer choices should be completely reasonable. If the distracters are farfetched, students will too easily locate the correct answer, even if they have little knowledge. When testing for recognition of key terms and ideas keep the distractors similar in length and type of language as the correct solution. When testing conceptual understanding, distractors should represent common mistakes made by students.

. b) Short Answer (SA) descriptive ……marks as applicable)

A short answer question as the term indicate is one to which a brief answer can be given. When the students are required to give a brief and precisely defined response, the suitable type is the restricted response questions. The specific form of the answer should also be indicated, e.g., List, Define, Give reason etc.

While framing a question requiring short answer it should be ensured that:

1. The statement constituting the question is simple, clear and unambiguous.
2. The scope of the answer is limited.
3. The direction given in the question is clear.
4. The question constitutes a valid testing situation for the ability under consideration
5. The question is likely to be interpreted in the same way by teachers/ students/ examiners.
6. The question does not require further restructuring.

b) Long Answers (LA) ……marks as applicable)

Long Answer (LA)

As the term indicates a long answer question is the one that needs a comprehensive explanation incorporating different ideas. The question should require the student to organise his ideas, choose the form of his answer and answer in his own words.

While framing a question requiring a long answer it should be ensured that:

1. The situation presented in the question is not new to most of the students.
2. The student will not be able to produce in the full, memorised answer.
3. The question involves the use of judgment on the part of student.
4. The answer can be completed within the limited time given.
5. The length and the scope of the answer is specified.

Table: Credits distribution among Courses for PG Master's Degree Programme
Programme: M Sc (Applied Electronics)

Sem	**DSC**		**DSE**		**SEC**		**AEC**		**Project/ Dissertation**	**Other Exam Credit/Courses**	**Ancillary Credit Courses**
	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	Total Credits		
First	8	31	--	--	--	--	1	2	--		Internship, OEC, curricular, Co-curricular, Extra-curricular Activities
Second	8	22	1	5	--	--	1	1			
Third	4	11	1	5	3	3	1	1	3		
Fourth	5	20	1	5	--	--	1	1	3		
Total		84	3	15	3	3	4	5			Minimum OEC: 5 Internship: 2

A) Total Credits of (DSC + DSE + Project/Dissertation) = 99
B) Total Credits of Ancillary Credit Courses (Minimum) = 7
C) Total Credits of (AEC + SEC + Other Exam. Courses): 5 + 3
D) Total Credits Offered : A + B + C = 114

1. Minimum No. of Credits to be earned to be eligible to get the Degree : E = 114 ($E \leq D$)
2. Minimum No. of credits from (DSC+DSE) course to be eligible to get the degree : 80% of E = 91
3. Minimum No. of credits from Ancillary credits courses to be earned : 10% of E OR 7 (Absolute no.) = 7
4. No. of credits from any University approved courses : 10% of E OR Balance (Absolute no.)