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Campus: Green Fields, Vaddeswaram - 522 302, Guntur District, Andhra Pradesh, INDIA
Phone No. 08645 - 350200, www.klef.ac.in; www.klef.edu.in; www.kluniversity.in
Admin Off: 29-36-38, Museum Road, Governorpet, Vijayawada - 520 002, Ph: +91 - 866 - 3500122, 2577715, 2576129

XXIX Academic Council - Annexure 2.8

Date: 24/06/2020

Department of Electronics and Communication Engineering

Minutes of 18th BOS Meeting

The Department BOS Meeting held on 24th June 2020 (Online mode) from 1:30 pm onwards

Following members are present

1. Dr. M. Suman, Professor & HoD, BoS Chair
2. Dr. Vinay Kumar Mittal, Professor and Dept. Chair, Member
3. Dr. L. Koteswara Rao, HOD-ECE and Professor KLH, Member
4. Dr. M. Goutham, Assoc. Professor, KLH, Member
5. Dr. Habibullah Khan, Professor & Dean Student Affairs, Member
6. Dr. V Rajesh, Professor & Dean P & D, Member
7. Dr. K.Sarat Kumar, Professor, Member
8. Dr. A.S.C.S.Sastry, Professor & COE, Member
9. Dr. K.Ch.Sri Kavya, Professor, Member
10. Dr. M Venkata Narayana, Professor & DHOD, Member
11. Dr. Madhukar Deshmukh, Professor & DHOD, Member
12. Dr. Lakshman Pappula, Assoc. Professor & DHOD, Member
13. Dr. I.Govardhani, Professor & RPAC, Member
14. Dr. M.Siva Ganga Prasad, Professor & HOD ECM, Member
15. Dr. P. Satya Srinivas Babu, Professor, Member
16. Dr. P Satyanarayana, Professor, Member
17. Dr. PVV Kishore, Professor, Member
18. Dr. M Sridhar, Professor, HOD-BES, Member
19. Dr. S Koteswara rao, Professor, Member
20. Dr. G V Subbarao, Professor & RPAC, Member
21. Dr. M Venugopal Rao Professor & Assoc. Dean IQAC, Member
22. Dr. BTP Madhav, Professor & Assoc. Dean R&D, Member
23. Dr. D Venkat Ratnam, Professor, Member
24. Dr. K Srinivas Rao, Professor, Member
25. Dr. K Kumar Naik, Professor, Member
26. Dr. V. S. V. Prabhakar, Professor & Director IC, Member
27. Dr. K.S.Ramesh, Professor, Member
28. Dr. K.Hari Kishore, Professor & Assoc. Dean, Member
29. Dr. Md.Z Rehman, Professor, Member
30. Dr. P.Pardhasaradhi, Professor, Member
31. Dr. B.Polaiah, Professor, Member
32. Dr. Fazal Noorbasha, Assoc. Professor & Assoc. Dean, Member
33. Dr. Arun Metha, Assoc. Professor, Member
34. Dr. M. Ravi Kumar, Asst. Professor, Member

Following member is absent
Nil

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AGENDA and RESOLUTIONS

AGENDA ITEM-1

Approval of DAC minutes of meeting	Recommended and forwarded to AC for approval

The minutes of the DAC meeting held on 22 June 2020 were discussed among the members. The minutes were approved.

[Annexure I]

AGENDA ITEM-2

Discussion on feedback analysis and action taken report	Recommended and forwarded to AC for approval

BOS Members discussed about the recommendation received from the DAC minutes and the status has given in the Annexure II.

[Annexure II]

AGENDA ITEM-3

To revise the syllabus for the courses "Optical Communication & Network" and "Satellite Communications" based on the stake holder feedback	Recommended and forwarded to AC for approval

Resolved to approve the modifications of syllabus for the B.Tech. ECE elective course offered in AY 2020-21 odd semester for 3rd year students.

- Based on the feedback received from industry personal Dr. Subba Rao, Head Budget, P&M division, NRSC, Bengaluru and Garisa Sreekar Reddy, Student, KLEF Syllabus for specialization elective courses "18EC3094: Optical Communication & Network" is revised for B. Tech (ECE). Optical communication is a rapidly evolving field with continuous advancements in technologies such as fiber optics, lasers, and photonic devices. Updating the syllabus ensures that students are exposed to the latest developments, enabling them to understand and work with cutting-edge optical technologies.
- Based on the feedback received from Dr. Subba Rao, Head Budget, P&M division, NRSC, Bengaluru Syllabus for specialization elective courses "18EC3093: Satellite Communications" is revised by added "Satellite Link Design" for B. Tech (ECE). The field of satellite communications is closely tied to industry applications such as telecommunications, broadcasting, remote sensing, and navigation. Aligning the syllabus with the current needs and practices of the industry ensures that students are well-prepared for the challenges that they may encounter in their careers.

S. No.	Course Code	Course Title	% of syllabus revised	Year of offering
1.	18EC3094	Optical Communication & Network	50	3rd yr (II Sem)

Dr. M. SUMAN
Professor & Head
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2.	18EC3093	Satellite Communications	25	3rd yr (II Sem)

The detailed syllabus is added in annexure III

AGENDA ITEM-4

Proposed to introduce elective courses for B.Tech. ECE 2020-21 admitting batch based on the feedback received from the stakeholders	Recommended and forwarded to AC for approval

- Based on the feedback received from Mr. T Sarath Babu, Director, Oracle Corporate, Hyderabad new elective course "20EC3085: Adaptive Signal Processing" is introduced for B. Tech ECE. Adaptive signal processing is a critical component of modern technologies such as telecommunications, audio processing, image processing, and sensor networks. Introducing a course in this field ensures that students gain essential knowledge and skills that are directly applicable to contemporary technology trends.
- Based on the feedback received from Dr. P. V. V. Kishore, Professor, KLEF, new elective course "20EC3083: Bio-Medical Image Analysis" is introduced for B.Tech. ECE. Medical imaging plays a crucial role in modern healthcare for diagnosis, treatment planning, and monitoring of various medical conditions. The demand for professionals with expertise in biomedical image analysis is increasing as medical imaging technologies continue to advance.
- Based on the feedback received from Mr. R Nagesh, Associate Director, CDAC, Bengaluru new elective course "20EC3061: Low Power VLSI" is introduced for B.Tech. ECE. The ubiquity of portable electronic devices, such as smartphones, wearables, and IoT sensors, underscores the importance of low-power design. A specialized course prepares students to address the unique challenges associated with designing energy-efficient circuits for battery-operated and energy-harvesting devices.

S. No.	Course Code	Course Title	Course Type	Remarks
1.	20EC3085	Adaptive Signal Processing	Professional Electives	This course is introduced as elective based on stake holders feedback
2.	20EC3083	Bio-Medical Image Analysis	Professional Electives	This course is introduced as elective based on stake holders feedback
3.	20EC3061	Low Power VLSI	Professional Electives	This course is introduced as elective based on stake holders feedback

The detailed syllabus is added in annexure III

[Annexure-III]

Dr. M. SUMAN
Professor & Head
Department of ECE
KLEF
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

AGENDA ITEM-5

Approval of course structure of B.Tech. programs for AY 2020-21.	Recommended and forwarded to AC for approval

1. Modified course structure for 2020-21 was discussed.
2. Valuable inputs from the internal and external experts have been taken towards revamping the entire B.Tech. programs.
3. Members have suggested adding VLSI Signal Processing course in the core course instead of elective course.
4. External members suggested modifying titles of few courses.

[Annexure-IV]

AGENDA ITEM-6

Approval of course structure of M. Tech programs for AY 2020-21.	Recommended and forwarded to AC for approval

1. Modified course structure for 2020-21 was discussed.
2. Valuable inputs from the internal and external experts have been taken towards revamping the entire M. Tech (VLSI Design and RADAR & Communication) programs.
3. All the external members suggested including a mathematics course into the program (RADAR & Communication)
4. External members suggested modifying titles of few courses.
5. All the external members suggested having Deep learning with Artificial Intelligence as common elective course for all M. Tech specializations.

[Annexure- V, VI]

AGENDA ITEM-7

Approval on Y20 Employability, Entrepreneurship, Skill Development Courses	Recommended and forwarded to AC for approval

All the BoS members approved the Y20 Employability, Entrepreneurship, Skill Development Courses. [Annexure III]

AGENDA ITEM-8

List of value-added courses for odd and even semester AY 2020-2021	Recommended and forwarded to AC for approval

Resolved to approve of value-added course for odd and even semester AY 2020-21 under B.Tech. program for Y19, Y18, Y17 regulation students

[Annexure-VII]

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

AGENDA ITEM-9

Proposed to introduce core and elective courses for M. Tech VLSI program from AY 2020-21 admitting batch based on the feedback received from the stakeholders.	Recommended and forwarded to AC for approval

Resolved to approve of the new courses in M.Tech (VLSI) from the AY 2020-21 based on the recommendation of industry personnel and academic peers to improve skills and increase employment opportunities. Consolidated report from stake holders is shown below.

1. Based on the feedback received from industry personal Dr. Thangavel Pichaiappa Rajesh, Professor, Anna University, Tirchy, "Advanced Computer Architecture Design (20EC52T5)" syllabus is introduced for M. Tech. VLSI. A specialized course in advanced computer architecture design allows students to delve deeper into the intricacies of designing complex computer systems. This includes studying advanced concepts related to processor design, memory hierarchy, pipelining, and parallel processing, providing a comprehensive understanding of how modern computer architectures are structured.
2. Based on the feedback received from industry personal Mr. T Sarath Babu, Director, Oracle Corporate, Hyderabad, Professional core course "Analog IC Design & Design for Testability (20EC5129)" is introduced in place of Advanced Analog IC Design for M. Tech. VLSI. Integrating DFT concepts into analog IC design aligns with the current needs of the semiconductor industry. As the complexity of ICs' increases, the importance of designing circuits that are testable and can be easily diagnosed for faults becomes paramount. This modification ensures that graduates are well-prepared for real-world challenges in IC design and manufacturing.
3. Based on the feedback received from industry personal Mr. Srinivas Vedala, Apple Inc., Bengaluru, Professional core course "ASIC & FPGA Design (20EC5130)" is introduced in place of ASIC Design Flow for M. Tech. VLSI. The "ASIC & FPGA Design" course provides a broader scope by encompassing both ASIC (Application-Specific Integrated Circuit) and FPGA (Field-Programmable Gate Array) design. This comprehensive approach allows students to gain a more versatile skill set, as both ASICs and FPGAs are widely used in different applications and industries.
4. Based on the feedback received from industry personal Dr. Pinky Steffi Alexander, Assistant professor, Sri Ramakrishna Engineering College, Coimbatore, "Cryptography and Network Security (20EC52T4)" syllabus is introduced for M.Tech. VLSI. Cybersecurity threats, including malware, phishing, and denial-of-service attacks, pose significant risks to individuals and organizations. A course in cryptography and network security provides students with the knowledge to analyze and prevent various types of cyber-attacks, enhancing their ability to contribute to the defense against evolving threats.
5. Based on the feedback received from industry personal Mr. R Nagesh, Associate Director, CDAC, Bengaluru, Syllabus for Professional elective course "Deep Learning with Artificial Intelligence (20EC51R1)" is introduced for M. Tech. VLSI. Many industries, including

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

healthcare, finance, technology, and manufacturing, are increasingly leveraging deep learning techniques to enhance their products and services. There is a growing demand for professionals with expertise in both AI and deep learning. Introducing a course in this area helps meet the industry's need for skilled practitioners.

6. Based on the feedback received from industry personal Dr. Narendhar. C., Research Assistant professor, Gachon University, Seongnam, Professional elective course "Network on Chip (20EC52T3)" is introduced for M. Tech. VLSI. As integrated circuits become more complex, with multiple processor cores and diverse IP blocks on a single chip, efficient communication between these components is critical. A "Network on Chip" course addresses the need for students to understand and design scalable on-chip communication architectures.
7. Based on the feedback received from industry personal Dr. Selvarajan. E., Assistant professor, SRM Institute of Science and Technology, Chennai, Tamil Nadu, Professional elective "Reconfigurable Computing (20EC52S5)" is introduced for M. Tech. VLSI. Reconfigurable computing, which includes technologies such as FPGAs (Field-Programmable Gate Arrays) and other reconfigurable devices, is gaining prominence in the computing industry. Introducing a course in this area ensures that students are exposed to and equipped with the skills needed to work with these emerging technologies.
8. Based on the feedback received from industry personal Mr. Sunil Kumar Raj Sodadas, Head Supply Chain Solutions, Signode India Ltd., Hyderabad, Professional elective course "VLSI Circuits for Bio-Medical Applications (20EC51R5)" is introduced for M. Tech. VLSI. The integration of VLSI circuits with biomedical applications is gaining prominence, with advancements in healthcare technology, medical devices, and diagnostics. Introducing a course in this area reflects the growing demand for engineers with expertise in both VLSI design and biomedical engineering.
9. Based on the feedback received from industry personal Dr. Senthil Sivakumar, Asst. Prof., IIIT Tiruchirappalli, Professional elective course "VLSI Data Convertors (20EC52S2)" is introduced for M. Tech. VLSI. Data converters, such as Analog-to-Digital Converters (ADCs) and Digital-to-Analog Converters (DACs), play a crucial role in modern electronic systems. As the demand for high-performance and high-resolution data conversion continues to rise in various applications (e.g., communication systems, sensors, audio processing, and medical devices), a dedicated course on VLSI Data Converters becomes relevant.
10. Based on the feedback received from industry personal Dr. Senthil Sivakumar, Asst. Prof., IIIT Tiruchirappalli, Professional elective course "VLSI for Wireless Communication (20EC52S4)" is introduced for M. Tech. VLSI. VLSI plays a crucial role in the design and implementation of wireless communication systems. Introducing a specialized course allows students to delve into the intricacies of integrating VLSI components into wireless devices, covering aspects such as power efficiency, signal processing, and communication protocols.
11. Based on the feedback received from industry personal Mr. R Nagesh, Associate Director, CDAC, Bengaluru, Professional core course "Low Power VLSI System Design (20EC5233)" is introduced for M.Tech. VLSI in place of Low Power VLSI Circuits. As technology evolves, there is a growing emphasis on the system-level design of integrated circuits. Focusing on "Low Power VLSI System Design" allows students to consider the broader context of VLSI

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

systems, including interactions between different components and their impact on power consumption. This systems-level approach is increasingly important in the design of modern electronic devices.

12. Based on the feedback received from industry personal Mr. Visweswaran Jagadeesan, Country Manager, National Instruments, Bengaluru, Professional core course "RF IC Design & Introduction to MM Radar (20EC5232)" is introduced for M. Tech. VLSI in place of HDL & PLD Architectures. There may be an increasing demand in the industry for professionals with expertise in RF IC (Radio Frequency Integrated Circuit) design and millimeter-wave radar technologies. Aligning the curriculum with industry demand ensures that graduates are well-prepared for job opportunities and are equipped with skills that are currently sought after.

S. No.	Course Code	Course Title	Course Type	Remarks
1.	20EC52T5	Advanced Computer Architecture Design	Professional Elective	This course is introduced as elective based on stake holders feedback
2.	20EC5129	Analog IC Design & Design for Testability	Professional Core	Advanced Analog IC Design is replaced with Analog IC Design & Design for Testability
3.	20EC5130	ASIC & FPGA Design	Professional Core	ASIC Design Flow is replaced with ASIC & FPGA Design course.
4.	20EC52T4	Cryptography and Network Security	Professional Elective	This course is introduced as elective based on stake holders feedback
5.	20EC51R1	Deep Learning with Artificial Intelligence	Professional Elective	This course is introduced as elective based on stake holders feedback
6.	20EC52T3	Network on Chip	Professional Elective	This course is introduced as elective based on stake holders feedback
7.	20EC52S5	Reconfigurable Computing	Professional Elective	This course is introduced as elective based on stake holders feedback
8.	20EC51R5	VLSI Circuits for Bio-Medical Applications	Professional Elective	This course is introduced as elective based on stake holders feedback

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

9.	20EC52S2	VLSI Data Convertors	Professional Elective	This course is introduced as elective based on stake holders feedback
10.	20EC52S4	VLSI for Wireless Communication	Professional Elective	This course is introduced as elective based on stake holders feedback
11.	20EC5233	Low Power VLSI System Design	Professional Core	Low Power VLSI Circuits is replaced with Low Power VLSI System Design.
12.	20EC5232	RF IC Design & Introduction to MM Radar	Professional Core	RF IC Design & Introduction to MM Radar course is introduced in placed of HDL & PLD Architectures

The detailed syllabus is added in annexure V

[Annexure-V]

AGENDA ITEM-10

Proposed to introduce core and elective courses for M. Tech Radar and Communication (R&C) program from AY 2020-21 admitting batch based on the feedback received from the stakeholders.	Recommended and forwarded to AC for approval

Resolved to approve of the new courses in M.Tech (R&C) from the AY 2020-21 based on the recommendation of industry personnel and academic peers to improve skills and increase employment opportunities. Consolidated report from stake holders is shown below.

1. Based on the feedback received from industry personal Mr. EBSV Chara, Lead RF, Honeywell, Hyderabad, Professional core course "4G, 5G, and Modern Wireless Technologies (20EC5205)" is introduced for M. Tech. R&C in place of Microwave and Millimetric wave Circuits. The telecommunications industry is rapidly transitioning to 4G and 5G technologies, representing a paradigm shift in wireless communication. A course focusing on these modern wireless technologies ensures that students are equipped with the skills and knowledge required by the industry, aligning the curriculum with current market demands.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
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Guntur Dist., A.P. PIN: 522 502

2. Based on the feedback received from industry personal Mr. T Sarath Babu, Director, Oracle Corporate, Hyderabad, Professional core course "Advanced Communication Systems & Networks (20EC5206)" is added for M. Tech. R&C in place of Wireless Cellular Communication. "Advanced Communication Systems & Networks" can offer a more comprehensive coverage of various communication technologies beyond just wireless cellular communication. It may include topics such as satellite communication, optical communication, Internet of Things (IoT), 5G and beyond, and emerging communication paradigms. This broadens the knowledge base of students, making them well-rounded professionals in the field.
3. Based on the feedback received from Dr. Anil Vuppala, Asst. Prof., IIIT Hyderabad and Mr. EBSV Chara, Lead RF, Honeywell, Hyderabad, Professional elective "Automotive Electronics and Avionics (20EC52D4)" is introduced for M. Tech. R&C. The automotive and avionics industries are undergoing a significant transformation with the increasing integration of electronic systems. Introducing a specialized course addresses the growing importance of electronics in the design, operation, and maintenance of vehicles and aircraft.
4. Based on the feedback received from Mr. EBSV Chara, Lead RF, Honeywell, Hyderabad, Professional elective course "Cloud Computing and Cyber Security (20EC52D2)" is introduced for M. Tech. R&C. A course on cloud computing and cybersecurity can include hands-on exercises, projects, and case studies to allow students to apply theoretical knowledge to real-world scenarios. This practical approach enhances their problem-solving skills and prepares them for the practical challenges they may face in the workforce.
5. Based on the feedback received from Mr. Visweswaran Jagadeesan, Country Manager, National Instruments, Bengaluru, Professional elective course "Embedded Systems and VLSI for Wireless (20EC51A4)" is introduced for M. Tech. R&C. The course integrates two critical domains, namely embedded systems and VLSI, providing students with a comprehensive understanding of how these technologies synergize to enable wireless communication systems. This holistic approach is crucial as embedded systems and VLSI play pivotal roles in the design and implementation of wireless devices and networks.
6. Based on the feedback received from Dr. Subba Rao, Head Budget, P&M division, NRSC, Bengaluru, Professional elective course "EMI/EMC & Electronic Warfare (20EC51A1)" is introduced for M. Tech. R&C. Electronic systems are pervasive in modern society, and ensuring their proper functioning is crucial. Introducing a course on EMI/EMC educates students about the principles, standards, and techniques necessary to mitigate electromagnetic interference and ensure electromagnetic compatibility. This knowledge is essential for the reliable operation of electronic devices in various applications.
7. Based on the feedback received from Mr. Sunil Kumar Raj Sodadas, Head Supply Chain Solutions, Signode India Ltd, Hyderabad, Professional elective course "Machine Learning and Soft Computing Applications in Communication (20EC52D1)" is introduced for M. Tech. R&C. ML and soft computing techniques can enhance the efficiency of communication systems by optimizing resource allocation, improving network performance, and mitigating communication challenges. A course in this area can equip students with the tools to design more efficient and intelligent communication systems.

8. Based on the feedback received from industry personal Mr. R Nagesh, Associate Director, CDAC, Bengaluru, Professional core course "Modern Digital and Wireless Communication (20EC5101)" is introduced for M. Tech. R&C in place of Modern Digital communication. The demand for professionals with expertise in both digital and wireless communication is growing. Employers often seek individuals who can navigate the complexities of modern communication systems, which frequently integrate both digital and wireless components. Aligning the syllabus with industry needs ensures that graduates are well-prepared for the current job market.
9. Based on the feedback received from industry personal Mr. Srinivas Vedala, Apple Inc., Bengaluru, Professional core course "Modern Radar Systems and Autonomous Vehicles (20EC5207)" is introduced for M. Tech. R&C in place of Modern RADAR Systems. Autonomous vehicles, which rely heavily on radar technology for navigation and obstacle detection, represent a rapidly growing and influential area of technology. Introducing a course that combines modern radar systems with autonomous vehicles reflects the current trend of integrating multiple technologies for complex applications.
10. Based on the feedback received from industry personal D. Ramakrishna, CEO, Efftronics, Vijayawada, Professional elective course "Next Generation Networking and Communication Technologies (20EC51B3)" is introduced for M. Tech. R&C. The field of networking and communication is undergoing significant transformations with the emergence of technologies such as 5G, 6G, edge computing, and the Internet of Things (IoT). Introducing a course that focuses on next-generation technologies ensures that students are exposed to the latest developments in the field.
11. Based on the feedback received from Dr. Subba Rao, Head Budget, P&M division, NRSC, Bengaluru, Professional core course "Optical Networks & Satellite Communications (20EC5208)" is introduced for M. Tech. R&C in place of GPS & Global Navigation Satellite System. The convergence of optical networks and satellite communications is becoming more prevalent. Optical fiber networks are often used as backbones for satellite communication systems, providing high-capacity and low-latency data transmission. Integrating these topics into a single course reflects the real-world scenario where these technologies often complement each other.
12. Based on the feedback received from Mr. Sunil Kumar Raj Sodadas, Head, Supply Chain Solutions, Signode India Ltd., Hyderabad, Professional core course "Radar Engineering & MM Radar (20EC5103)" is introduced for M. Tech. R&C in place of Radar Engineering. Modern radar systems often include advanced features such as Multifunctional Modular (MM) capabilities, which enable the radar to perform multiple tasks simultaneously. Introducing a course that specifically covers both Radar Engineering and MM Radar ensures that students are familiar with the latest radar technologies and can address the complexities associated with multifunctional radar systems.
13. Based on the feedback received from industry personal Mr. EBSV Chara, Lead RF, Honeywell, Hyderabad, Professional core course "RF System and Antenna Design (20EC5104)" is introduced for M. Tech. R&C in place of Microwave Antennas. The term "RF System and Antenna Design" suggests a broader scope that encompasses not only

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

antennas but also the entire RF system. This modification allows for a more comprehensive study that includes both the design and integration of antennas within larger RF systems, providing students with a more holistic understanding of the subject.

S. No.	Course Code	Course Title	Course Type	Remarks
1.	20EC5205	4G, 5G, and Modern Wireless Technologies	Professional Core	Microwave and Millimetric wave Circuits is replaced with 4G, 5G, and Modern Wireless Technologies.
2.	20EC5206	Advanced Communication Systems & Networks	Professional Core	Wireless Cellular Communication is replaced with Advanced Communication Systems & Networks.
3.	20EC52D4	Automotive Electronics and Avionics	Professional Elective	This course is introduced as elective based on stake holders feedback
4.	20EC52D2	Cloud Computing and Cyber Security	Professional Elective	This course is introduced as elective based on stake holders feedback
5.	20EC51A4	Embedded Systems and VLSI for Wireless	Professional Elective	This course is introduced as elective based on stake holders feedback
6.	20EC51A1	EMI/EMC & Electronic Warfare	Professional Elective	This course is introduced as elective based on stake holders feedback
7.	20EC52D1	Machine Learning and Soft Computing Applications in Communication	Professional Elective	This course is introduced as elective based on stake holders feedback
8.	20EC5101	Modern Digital and Wireless Communication	Professional Core	Modern Digital communication is replaced with Modern Digital

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
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				and Wireless Communication.
9.	20EC5207	Modern Radar Systems and Autonomous Vehicles	Professional Core	Modern RADAR Systems is replaced with Modern Radar Systems and Autonomous Vehicles.
10.	20EC51B3	Next Generation Networking and Communication Technologies	Professional Elective	This course is introduced as elective based on stake holders feedback
11.	20EC5208	Optical Networks & Satellite Communications	Professional Core	GPS & Global Navigation Satellite System is replaced with Optical Networks & Satellite Communications.
12.	20EC5103	Radar Engineering & MM Radar	Professional Core	Radar Engineering is replaced with Radar Engineering & MM Radar
13.	20EC5104	RF System and Antenna Design	Professional Core	Microwave Antennas is replaced with RF System and Antenna Design

The detailed syllabus is added in annexure VI

[Annexure-VI]

AGENDA ITEM-11

Recommendation to approve BOS minutes in Academic Council.	Recommended and forwarded to AC for approval

The members had a brainstorming discussion and interaction among themselves. Based on the suggestions given by the members, BoS resolved to recommend the following to the Academic Council for further approval.

AGENDA ITEM-12

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
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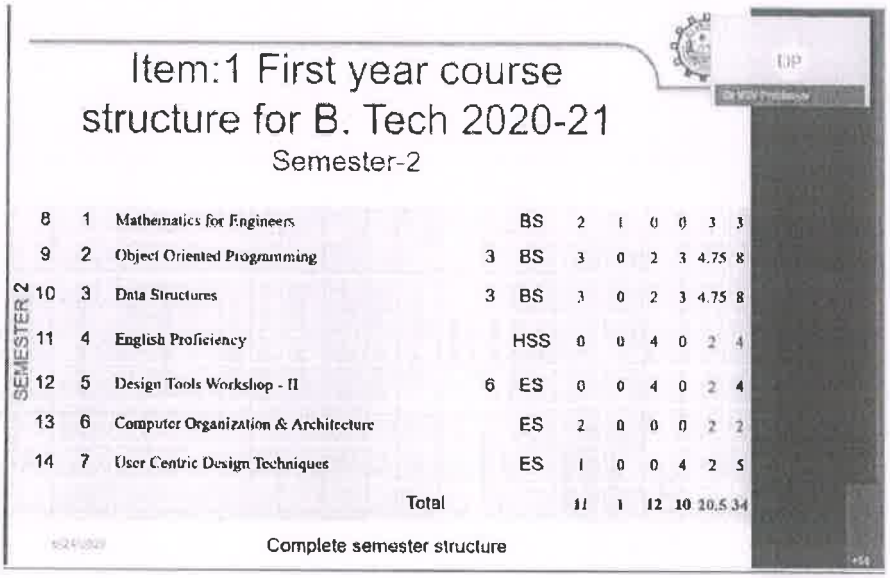
Any other matter	Recommended and forwarded to AC for approval

1. Dr. Anil Kumar suggested to have Machine Learning or Artificial Intelligence as common elective courses for M. Tech programs.
2. Dr. Kishore Kumar suggested to review the titles of science electives.
3. Dr. Subba Rao suggested to have course on Deep Learning with AI as elective course for M. Tech programs.
4. Mr. Visweswaran J, suggested to have 2 credit mathematic course with for M. Tech RADAR & Communications
5. Dr. Kishore Kumar Suggested to develop M. Tech course structure in accordance with AICTE guidelines.
6. Dr. Anil Kumar suggested to have course codes according to the level of the course.



Item:1 First year course structure for B. Tech 2020-21

Semester-2

SEMESTER 2	8	1	Mathematics for Engineers		BS	2	1	0	0	3	3
	9	2	Object Oriented Programming	3	BS	3	0	2	3	4.75	8
	10	3	Data Structures	3	BS	3	0	2	3	4.75	8
	11	4	English Proficiency		HSS	0	0	4	0	2	4
	12	5	Design Tools Workshop - II	6	ES	0	0	4	0	2	4
	13	6	Computer Organization & Architecture		ES	2	0	0	0	2	2
	14	7	User Centric Design Techniques		ES	1	0	0	4	2	5
			Total			11	1	12	10	20.5	34

Complete semester structure

Dr. M. SUMAN
Professor & Head
Department of ECE
KLEF
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

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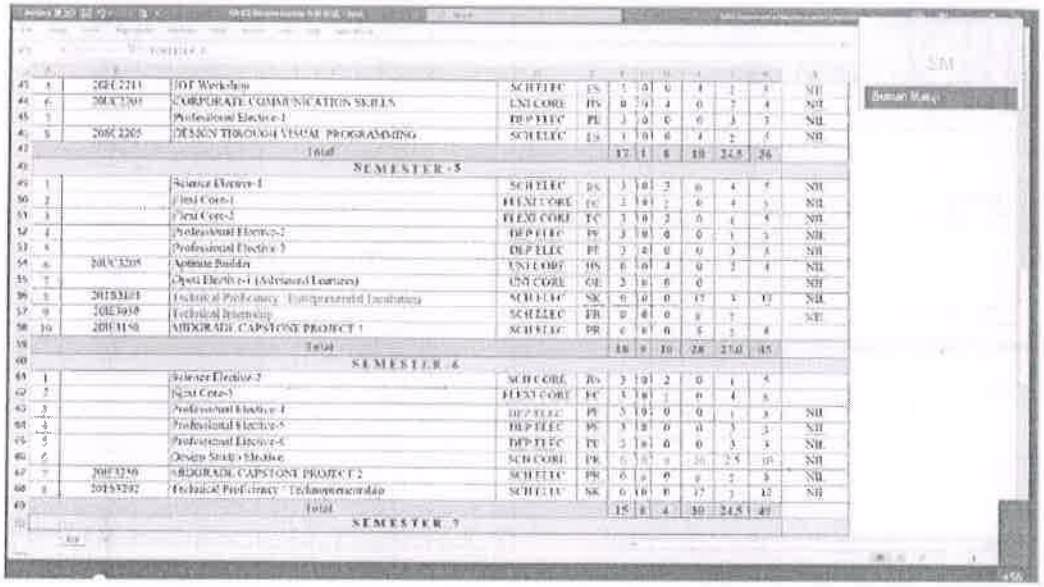

43	5	20EC2211	IOT Workshop	SCH ELEC	ES	1	0	0	1	1	1	NIL
44	6	20EX2203	CORPORATE COMMUNICATION SKILLS	UNI CORE	HS	0	2	1	0	2	1	NIL
45	7		Professional Elective-1	DEP ELEC	PE	3	0	0	0	3	3	NIL
46	8	20EC2205	DESIGN THROUGH VISUAL PROGRAMMING	SCH ELEC	ES	1	0	0	1	2	1	NIL
47			Total			17	1	8	18	24.5	26	
48			SEMESTER - 5									
49	1		Science Elective-1	SCH ELEC	ES	3	0	2	0	4	5	NIL
50	2		Hard Core-1	HARD CORE	PC	3	0	2	0	4	5	NIL
51	3		Hard Core-2	HARD CORE	PC	3	0	2	0	4	5	NIL
52	4		Professional Elective-2	DEP ELEC	PE	3	0	0	0	3	3	NIL
53	5		Professional Elective-3	DEP ELEC	PE	3	0	0	0	3	3	NIL
54	6	20EX2205	Aptitude Builder	UNI CORE	HS	0	0	4	0	2	4	NIL
55	7		Open Elective-1 (Advanced Learners)	UNI CORE	OE	3	0	0	0			NIL
56	8	20ES3101	Technical Proficiency - Entrepreneurial Initiatives	SCH UNI	SK	0	0	0	12	3	12	NIL
57	9	20IE3010	Technical Internship	SCH ELEC	PR	0	0	0	0	2		NIL
58	10	20EC3150	MIDGRADE CAPSTONE PROJECT 1	SCH ELEC	PR	0	0	6	0	3	4	
59			Total			18	0	10	28	27.0	45	
60			SEMESTER - 6									
61	1		Science Elective-2	SCH CORE	ES	3	0	2	0	4	5	
62	2		Hard Core-3	HARD CORE	PC	3	0	2	0	4	5	
63	3		Professional Elective-4	DEP ELEC	PE	3	0	0	0	3	3	NIL
64	4		Professional Elective-5	DEP ELEC	PE	3	0	0	0	3	3	NIL
65	5		Professional Elective-6	DEP ELEC	PE	3	0	0	0	3	3	NIL
66	6		Design Study - Elective	SCH CORE	PR	0	0	4	0	2	4	NIL
67	7	20EC3250	MIDGRADE CAPSTONE PROJECT 2	SCH ELEC	PR	0	0	6	0	3	3	NIL
68	8	20ES3202	Technical Proficiency - Technopreneurship	SCH UNI	SK	0	10	0	12	3	12	NIL
69			Total			15	0	4	30	24.5	41	
70			SEMESTER - 7									

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

Annexure I

DAC Minutes of Meeting

Annexure II

Stakeholder Feedback Analysis

Sl.No.	Name of the resource person	Designation & Affiliation	Recommendation on Curriculum during DAC meeting	Approval by BOS committee	Remarks
A.	**Industry Personnel**				
1.	Mr. Visweswaran Jagadeesan	Country Manager, National Instruments, Bengaluru	4G Wireless Technologies and Cellular Communication should be included	Approved	
2.	Mr. R Nagesh	Associate Director, CDAC, Bengaluru	Modern Digital and Wireless Communication can be included in M.Tech. R&C	Approved	
3.	Mr. Sunil Kumar Raj Sodadas	Head Supply Chain Solutions, Signode India Ltd., Hyderabad	it is useful to introduce a course like RADAR Engineering & mm Radar	Approved	
4.	Mr. EBSV Chara	Lead RF, Honeywell, Hyderabad	RF System and Antenna Design should be included in M. Tech R&C	Approved	
5.	Mr. T Sarath Babu	Director, Oracle Corporate, Hyderabad	Analog IC Design & Design for Testability could be included in M.Tech VLSI	Approved	
6.	Mr. Srinivas Vedala	Manager, Apple Inc., Bengaluru	ASIC & FPGA Design course is needed for M.Tech VLSI students	Approved	
7.	Dr. Subba Rao	Head Budget, P&M division,	EMI/EMC & Electronic Warfare could be included	Approved	

Dr. SUMAN
Professor & Head
Department of ECE
K. L. E. F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

		NRSC, Bengaluru	in the curriculum in M.Tech R&C		
8.	Mr. Visweswaran Jagadeesan	Country Manager, National Instruments, Bengaluru	Embedded Systems and VLSI for Wireless course can be included in the curriculum in M.Tech	Approved	
9.	D. Ramakrishna	CEO, Efftronics, Vijayawada	Next Generation Networking and Communication Technologies are to be introduced to the students in M.Tech	Approved	
10.	Mr. R Nagesh	Associate Director, CDAC, Bengaluru	He suggested to include a course on Deep Learning with Artificial intelligence for M.Tech VLSI students	Approved	
11.	Mr. Sunil Kumar Raj Sodadas	Head Supply Chain Solutions, Signode India Ltd., Hyderabad	VLSI Circuits for Bio Medical Applications is useful for a student in terms of bio-medical field for M.Tech VLSI	Approved	
12.	Mr. EBSV Chara	Lead RF, Honeywell, Hyderabad	He recommended to add a course related to 4G, 5G, and Modern Wireless Technologies in M.Tech R&C	Approved	
13.	Mr. T Sarath Babu	Director, Oracle Corporate, Hyderabad	Advanced Communication Systems & Networks could be included to the curriculum of M.Tech (R&C) and Adaptive Signal Processing in B. Tech.	Approved	

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Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

14.	Mr. Srinivas Vedala	Manager, Apple Inc., Bengaluru	Modern Radar Systems and Autonomous Vehicles could be included in the curriculum of M.Tech R&C	Approved	
15.	Dr. Subba Rao	Head Budget, P&M division, NRSC, Bengaluru	Optical Networks & Satellite Communications should be learnt by the student of M.Tech R&C and B.Tech.	Approved	
16.	Mr. Visweswaran Jagadeesan	Country Manager, National Instruments, Bengaluru	RF IC Design & Introduction to mm Radar should be included the curriculum of M.Tech VLSI	Approved	
17.	Mr. R Nagesh	Associate Director, CDAC, Bengaluru	course on Low power VLSI System Design should be studied by VLSI student	Approved	
18.	Mr. Sunil Kumar Raj Sodadas	Head Supply Chain Solutions, Signode India Ltd, Hyderabad	Course on Machine Learning and Soft Computing Applications in Communication should be there in M.Tech R&C	Approved	
19.	Mr. EBSV Chara	Lead RF, Honeywell, Hyderabad	He recommended to add a course related to Cloud Computing and Cyber Security in M.Tech R&C	Approved	
B.	**Academic Peers**				
20.	Dr. Anil Vuppala	Asst. Prof., IIIT Hyderabad	Automotive Electronics and Avionics course could be included in the curriculum in M.Tech R&C	Approved	

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Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
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21.	Dr. Senthil Sivakumar	Asst. Prof., IIIT Tiruchirappalli	VLSI Data Convertors course should be added in M.Tech VLSI	Approved	
22.	Dr. Selvarajan. E	Assistant professor, SRM Institute of Science and Technology, Chennai, Tamil Nadu	course on ReConfigurable Computing should be there in M.Tech VLSI	Approved	
23.	Dr. Narendhar. C	Research Assistant professor, Gachon University, Seongnam	Network On Chip course could be included in the curriculum of M.Tech VLSI	Approved	
24.	Dr. Senthil Sivakumar	Asst. Prof., IIIT Tiruchirappalli	VLSI for Wireless Communication could be included in the curriculum of M.Tech VLSI	Approved	
25.	Dr. Pinky Steffi Alexander	Assistant professor, Sri Ramakrishna Engineering College, Coimbatore	Cryptography and Network Security course could be included in the curriculum of M.Tech VLSI	Approved	
26.	Dr. Thangavel Pichaiappa Rajesh	Professor, Anna University, Tirchy	Course such as Advanced Computer Architecture Design is required for an M.Tech VLSI student in their curriculum	Approved	
27.	Dr. Anil Vuppala	Asst. Prof., IIIT Hyderabad	Technical Skilling-I (HDL) should be added	Approved	
C.	**Alumni**				
28.	Mr. Vinoz Chanamolu	President & CEO at IndSoft Naperville, Illinois, United States	Technical Skilling-I (MATLAB, AWR) should be focused on the programming	Approved	

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

			using MATLAB for M.Tech R&C		
29.	Rasamsetti Anilbabu	Manager, Deccansoft Software Services	Technical Skilling-2 (MATLAB, AWR) course should be included which focuses on advanced projects for M.Tech R&C	Approved	
D.			**Faculty**		
30.	Md. Z. Rehman	Emp ID - 3413, Professor, KLEF, Vijayawada	He suggested to include Electronic Workshop-II (Electronic System Design Workshop) in the curriculum	Approved	
31.	Dr.P.V.V. Kishore	Emp ID - 3452, Professor, KLEF, Vijayawada	He suggested to include Bio-Medical Image Processing	Approved	
32.	Dr. Suman Malo	Emp ID – 841, Professor, KLEF, Vijayawada	He suggested to revise Technical Proficiency & Training in the curriculum	Approved	
E.			**Student**		
33.	Miss Alapati Siriveni	170040019, Student, KLEF, Vijayawada	She suggested to include orbital mechanics and satellite orbits in the syllabus of satellite communications	Approved	
34.	Mr. Garisa Sreekar Reddy	170040243, Student, KLEF, Vijayawada	He suggested to include the topics on optical receivers and detectors in Optical communication and network course	Approved	
35.	Miss K Harshitha	170040289, Student, KLEF, Vijayawada	She recommended to include the topics of signal representation and analysis in the	Approved	

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

			course Communication signals and system design		

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

Annexure III

Syllabus Revision / New

1. **Program structure (with all Courses) containing the following categorization**

Course Code	Course Name	Course Category	L	T	P	S	CR	Pre-Requisite	New / Revised / Retained	Stakeholder Category	Justification for considering the feedback
18EC3094	Optical Communication & Network	Practice based learning	3	0	0	0	3	Nil	Revised	Dr. Subba Rao Head Budget, P&M division, NRSC, Bengaluru Garisa Sreekar Reddy 170040243, Student, KLEF, Vijayawada	Optical communication is a rapidly evolving field with continuous advancements in technologies such as fiber optics, lasers, and photonic devices. Updating the syllabus ensures that students are exposed to the latest developments, enabling them to understand and work with cutting-edge optical technologies.
18EC3094	Satellite Communications	Practice based learning	3	0	0	0	3	NIL	Revised	Dr. Subba Rao Head Budget, P&M division, NRSC, Bengaluru	The field of satellite communications is closely tied to industry applications such as telecommunications, broadcasting, remote sensing, and navigation. Aligning the syllabus with the current needs and practices of the industry ensures that students are well-prepared for the challenges they may encounter in their careers.
20EC3085	Adaptive Signal Processing	Practice based learning	3	0	0	0	3	NIL	New	Mr. T Sarath Babu, Director, Oracle Corporate, Hyderabad	Adaptive signal processing is a critical component of modern technologies such as telecommunications, audio processing, image processing, and sensor networks. Introducing a course in this field ensures that students gain essential knowledge and skills that are directly applicable to contemporary technology trends.

20EC3083	Bio Medical Image Analysis	Practice based learning	3	0	0	0	3	NIL	New	Dr. P. V. V. Kishore Emp ID - 3452, Professor, KLEF, Vijayawada	Medical imaging plays a crucial role in modern healthcare for diagnosis, treatment planning, and monitoring of various medical conditions. The demand for professionals with expertise in biomedical image analysis is increasing as medical imaging technologies continue to advance.
20EC3061	Low Power VLSI	Practice based learning	3	0	0	0	3	NIL	New	Mr. R Nagesh Associate Director, CDAC, Bengaluru	The ubiquity of portable electronic devices, such as smartphones, wearables, and IoT sensors, underscores the importance of low-power design. A specialized course prepares students to address the unique challenges associated with designing energy-efficient circuits for battery-operated and energy-harvesting devices.

Course wise Syllabus revision of approved structure as mentioned in point 1(Program structure (with all Courses) containing following categorization).

Course Code	Course Name	Course Category	Existing Syllabus	New Syllabus	Topics Added / Removed / Replaced	Change in Outcome	Justification for the Modification	*Overall Revision Percentage
20EC4054	Optical Communication & Network	Practice based learning	**Overview of Optical Communication: Applications, Optical Fiber Waveguide, Types, Modes:** Optical Fiber Communication system, optical fiber waveguides, types of fibers, cutoff wave length: Introduction, Attenuation, absorption, scattering losses, bending loss, dispersion.	**Overview of Optical Communication: Applications, Optical Fiber Waveguide, Types, Modes:** Optical Fiber Communication system, optical fiber waveguides, types of fibers, cutoff wave length: Introduction, Attenuation, absorption, scattering losses, bending loss, dispersion, Intra	CO1: Intra model dispersion, Inter model dispersion **CO2:** multichannel transmission techniques, RF over fiber, **CO3:** tuneable optical fibers, dynamic gain equalizers,	CO2: understand different optical sources, materials and structures CO3: understand different optical sources, materials and structures	Professional elective course helps better employment	**50%**

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

			Optical Sources & Sensors: LED, ILD, Laser Diodes, Power-Bandwidth, Materials, Structures: Introduction, LED's, LASER diodes, Photo detectors, Photo detector noise, Photo diodes, Introduction, fiber alignment and joint loss, single mode fiber joints, fiber splices, fiber connectors and fiber couplers, Analog links – Introduction, overview of analog links, CNR, key link parameters, Radio over fiber links. **Optical Networks and Protocols: Node, Switching Element, WDM NW, PSTN, Transport Layer:** Digital links – Introduction, point–to–point links, System considerations, link power budget, resistive budget, short wave length band, transmission distance for single mode fibers, Power penalties, WDM standards, Interferometer, multiplexer, Isolators and circulators, active optical	model dispersion, Inter model dispersion. **Optical Sources & Sensors: LED, ILD, Laser Diodes, Power-Bandwidth, Materials, Structures:** Introduction, LED's, LASER diodes, Photo detectors, Photo detector noise, Photo diodes, Introduction, fiber alignment and joint loss, single mode fiber joints, fiber splices, fiber connectors and fiber couplers, Analog links – Introduction, overview of analog links, CNR, multichannel transmission techniques, RF over fiber, key link parameters, Radio over fiber links. **Optical Networks and Protocols: Node, Switching Element, WDM NW, PSTN, Transport Layer:** Digital links – Introduction, point–to–point links, System considerations, link power budget, resistive budget, short wave length band, transmission distance for single	optical drop multiplexers **CO4:** semiconductor optical amplifiers			

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

			components, variable optical attenuators, polarization controllers, chromatic dispersion compensators, tunable light sources. **Misc.: Optical Switching, Wavelength Routing, Optical NWs, EDFA, SONET, SDH, OTDR, FTDX:** Optical amplifiers, basic applications and types, EDFA. OPTICAL NETWORKS: Introduction, SONET / SDH, Optical Interfaces, SONET/SDH rings, High – speed light – waveguides. OTDR, FTTX networks, digital cross connects. (10Hrs)	mode fibers, Power penalties, WDM standards, Interferometer, multiplexer, Isolators and circulators, active optical components, variable optical attenuators, tuneable optical fibers, dynamic gain equalizers, optical drop multiplexers, polarization controllers, chromatic dispersion compensators, tunable light sources. **Misc.: Optical Switching, Wavelength Routing, Optical NWs, EDFA, SONET, SDH, OTDR, FTDX:** Optical amplifiers, basic applications and types, semiconductor optical amplifiers, EDFA. OPTICAL NETWORKS: Introduction, SONET / SDH, Optical Interfaces, SONET/SDH rings, High – speed light – waveguides. OTDR, FTTX networks, digital cross connects. (10Hrs)				
20EC4053	Satellite Communications	Practice based learning	**Introduction: Basic Concepts of Satellite Communications:** Basic Concepts of Satellite	**Introduction: Basic Concepts of Satellite Communications:** Basic Concepts of Satellite	CO2: Satellite Link Design: Basic	CO2: Design uplink and downlink budgets in	Professional elective course helps better employment	25%

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P.

			Communications, Frequency Allocations for Satellite Services, Applications. Types of satellites orbits, LEO, MEO and GEO satellites, Satellite in the context of India. Orbital Mechanics: Look Angle determination, Satellite Subsystems: Attitude and Orbit Control System, Telemetry, Tracking, Command and Monitoring, Power Systems, Communication Subsystems, Satellite Antennas. **Multiple Access Techniques:** Frequency Division Multiple Access (FDMA), Inter-modulation, Calculation of C/N, Time Division Multiple Access (TDMA), Frame Structure, Satellite Switched TDMA, Onboard Processing, Code Division Multiple Access (CDMA), Satellite RF impairments: Rain attenuation, Space weather effects on Satellite communications, Atmospheric drag.	Communications, Frequency Allocations for Satellite Services, Applications. Types of satellites orbits, LEO, MEO and GEO satellites, Satellite in the context of India. Orbital Mechanics: Look Angle determination, Satellite Subsystems: Attitude and Orbit Control System, Telemetry, Tracking, Command and Monitoring, Power Systems, Communication Subsystems, Satellite Antennas. **Satellite Link Design:** Basic Transmission Theory, System Noise Temperature and G/T Ratio, Design of Down Links, Up Link Design, Design of Satellite Links For Specified C/N, System Design Examples- DOMSAT, INSAT, INTELSAT and INMARSAT. Satellite-based personal communication. **Multiple Access Techniques:** Frequency Division Multiple Access (FDMA), Inter-modulation, Calculation of C/N,	Transmission Theory, System Noise Temperature and G/T Ratio, Design of Down Links, Up Link Design, Design of Satellite Links For Specified C/N, System Design Examples- DOMSAT, INSAT, INTELSAT and INMARSAT. Satellite- based personal communication. CO4: ITU regulations, Standards and examples, DBS and DBB.	Satellite communications		

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

			Satellite Navigation & Global Positioning System: Satellite Navigation & Global Positioning System: Radio and Satellite Navigation, GPS Position Location Principles, GPS Receivers and Codes, Satellite Signal Acquisition, GPS Navigation Message, GPS Signal Levels, GPS Receiver Operation. TCP over satellite.	Time Division Multiple Access (TDMA), Frame Structure, Satellite Switched TDMA, Onboard Processing, Code Division Multiple Access (CDMA), Satellite RF impairments: Rain attenuation, Space weather effects on Satellite communications, Atmospheric drag. **Satellite Navigation & Global Positioning System:** Satellite Navigation & Global Positioning System: Radio and Satellite Navigation, GPS Position Location Principles, GPS Receivers and Codes, Satellite Signal Acquisition, GPS Navigation Message, GPS Signal Levels, GPS Receiver Operation. TCP over satellite, ITU regulations, Standards and examples, DBS and DBB.				
18TP3101:	Technical Proficiency & Training -1	Practice based learning	VLSI Design: 1. Introduction to EDA tools. 2.CMOS circuit design. 3.Design and verify the functionality of CMOS Logic gates. 4.Design and verify the functionality of Boolean expression. 5.Design and	VLSI Design: 1. Introduction to EDA tools. 2.CMOS circuit design. 3.Design and verify the functionality of CMOS Logic gates. 4.Design and verify the functionality of Boolean expression. 5.Design and	CO4: Embedded & IOT: 1. Introduction to TINKERCAD and ARDUINO. 2.Introduction to Internet of	CO4: Applying the domain-based tool for project developments which can be	Skilling course helps better employment	25 %

M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

			verify the layout of CMOS Logic gates. Data Science: 1. Linear regression and regularization experiment on sample data. 2.K means algorithms and models on different data set. 3.Data Fundamentals and Hadoop Integration with R. 4.Predictive Analytics and Segmentation using Clustering 5.Implementation of decision tree model Wireless Communication: 1.Introduction to wireless communication and MATLAB 2.Analysis and simulation of path loss models for wireless communication. 3.Design and simulation of SISO. 4.Design and simulation of MISO. 5.Simulation of basic OFDM	verify the layout of CMOS Logic gates. Data Science: 1. Linear regression and regularization experiment on sample data. 2.K means algorithms and models on different data set. 3.Data Fundamentals and Hadoop Integration with R. 4.Predictive Analytics and Segmentation using Clustering 5.Implementation of decision tree model Wireless Communication: 1.Introduction to wireless communication and MATLAB 2.Analysis and simulation of path loss models for wireless communication. 3.Design and simulation of SISO. 4.Design and simulation of MISO. 5.Simulation of basic OFDM Embedded & IOT: 1. Introduction to TINKERCAD and ARDUINO. 2.Introduction to Internet of Things. 3.Communication with cloud (Thingspeak). 4.Monitoring Home appliances using IoT 5. Controlling devices using IoT	Things. 3.Communication with cloud (Thingspeak). 4.Monitoring Home appliances using IoT 5.Controlling devices using IoT Environment	used as a product		

Dr. K. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

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				Environment				

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

ADAPTIVE SIGNAL PROCESSING

Course Code : 20EC3085 Credits : 3

L-T-P-S : 3-0-0-0 Pre-requisites : NIL

Course Outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Comprehend design criteria and modelling adaptive systems and theoretical Performance evaluation	1,2	1,2
CO2	Design a linear adaptive processor and Kalman filters	1,2	3
CO3	Apply mathematical models for error performance and stability	1,2	3
CO4	Comprehend the estimation theory for linear systems and modelling algorithms.	2,4	1

Syllabus:

Winer Filters: FIR Wiener filters, linear prediction-forward and backward predictions, Levinson-Durbin Algorithm and lattice filter, IIR Wiener filters, non-causal Wiener filter, innovation and causal Wiener filter.

Kalman filters: Gauss-Markov state variable models; innovation and Kalman recursion, steady-state behavior of Kalman filters.

Adaptive filters: steepest descent solution of FIR Wiener filter, LMS algorithm- convergence, steady-state behavior and practical considerations, RLS algorithm- method of least-squares, recursive solution and square-root algorithms, application of adaptive filters-equalization and noise cancellation, models.

Advanced Adaptive algorithms: Normalized algorithms, Variable Step Size algorithms, Block based adaptive algorithms, Time domain and frequency domain, convergence analysis.

Text Books

1 S. Haykin, Adaptive Filter Theory, Pearson, 5ed, 2014

2 D.G. Manolakis, V.K. Ingle and S.M. Kogon, Statistical and Adaptive Signal Processing, McGraw Hill, 2000

3 Paula S. R. Diniz, "Adaptive Filtering, Algorithms and Practical Implementation", Third edition, Springer Publishers, 2008.

4 Ali H Syed, John Wiley and Sons, "Adaptive Filters", New Jersey, USA, 2008.

5 Farhang-Boroujeny, B., John Wiley and Sons, "Adaptive Filters-Theory and Applications", Chichester, UK, 1998.

Web References

1 https://onlinecourses.nptel.ac.in/

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 [illegible]

2 https://onlinecourses.nptel.ac.in/noc18_ee33/previe
3 https://drive.google.com/file/d/1IpksgYbRX2kD7LXLk62I3-LSnd8tSXz2k/view
4 https://www.youtube.com/watch?v=qqeRUgAvmzQ
5 https://www.youtube.com/watch?v=o1-hj6GKaFY
6 https://www.youtube.com/watch?v=2g13aC5blfA

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

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BIOMEDICAL IMAGE ANALYSIS

Course Code: 20EC3083 Credits: 3

L-T-P-S:3-0-0-0 Pre-requisite : NIL

Course Outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Fundamentals of Digital image	1,3	2
CO2	Image Enhancement in Spatial and Frequency domain	1,3	2
CO3	Image Segmentation and Compression	1,3	2
CO4	Morphological Image Processing and Advanced Topics	5	2

Syllabus:

Fundamentals of Digital image: Image formation, visual perception, CCD & CMOS Image sensor, Image sampling: Two-dimensional Sampling theory, Nonrectangular grid and Hexagonal sampling, Optimal sampling, Image quantization, Non uniform Quantization, Image formats. Types of pixel Operations, Types of neighborhoods, adjacency, connectivity, boundaries, regions, 2Dconvolution, Color models.

Image Enhancement in Spatial and Frequency domain: Basic gray level transformations, histogram processing, Smoothing operations, Edge Detection-derivative based operation, filtering in frequency domain, 2D-DFT, Smoothing frequency domain filters, Sharpening frequency domain filters, Homomorphic filtering.

Image Segmentation and Compression: Detection of discontinuities, Point-line- edge detection, Linear and Circular Hough Transform, Basic Global and Adaptive Thresholding, Region Based segmentation, K-Means Clustering. Fundamentals of Image compression models, Lossless compression: variable length coding, LZW coding, Arithmetic coding, Lossy compression: Wavelet and DCT coding, Predictive coding.

Morphological Image Processing and Advanced Topics: Dilation and Erosion, Opening and Closing, Hit-or-Miss transformation, Boundary Extraction, Region filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening, Skeletons, Pruning, Diffusion Tensor Imaging.

Text Books

1 Digital Image Processing, Gonzalez and Woods- Pearson Education
2 Digital Image Processing, S. Sridhar – Oxford University Press.
3 Fundamentals of Digital Image Processing, A.K. Jain .P.H.I.
4 Digital Image Processing, William Pratt- John Wiley.

Web References

1 https://www.coursera.org/lecture/image-processing/1-introduction-to-medical-imaging-duration-07-03-QhMgY
2 https://www.csie.ntu.edu.tw/~rfchang/lab/pdf/AIT/02MIP.pdf
3 https://www.youtube.com/watch?v=3qJej6wgezA
4 https://www.youtube.com/watch?v=IcBzsP-fvPo

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 507

5 https://www.youtube.com/watch?v=twsV81UFFcE

6 https://www.youtube.com/watch?v=gmi4ah7YAi0

Dr. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

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LOW POWER VLSI

Course Code: 20EC3061 Credits : 3
L-T-P-S: 3-0-0-0 Pre-requisites : NIL

Course Outcomes:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the physics of power dissipation including short circuit power, dynamic power and leakage power, techniques that makes a low power circuit and introduction to simulation power analysis.	**1,2**	1
CO2	Illustrate probabilistic power analysis and apply low power techniques at circuit level for CMOS circuits.	**1,2,3**	2
CO3	Apply low power techniques at gate level, architecture level and system levels.	**1,2,3**	2
CO4	Illustrate essential tasks in algorithm and architecture level low power design environments and apply low power clock tree distribution techniques to create low power devices.	**1,2**	2

Syllabus:

Low Power CMOS VLSI Design: Sources of Power Dissipation, Static and Dynamic Power Dissipation, Active Power Dissipation, Designing for low-power, Circuit techniques for leakage power reduction.

Simulation and Power Analysis: SPICE circuit Simulation, Discrete Transistor Modelling and Analysis, Gate level logic simulation, architecture level analysis, Date correlation analysis in DSP systems, monte carlo simulation. Random Logic Signals, Probability and Frequency, Probabilistic power analysis techniques, signal entropy.

Low Voltage, Low Power Adders and Multipliers: Standard Adder cells, CMOS Adder's architectures, Bi-CMOS Adders, Low-voltage, Low-power design techniques, Current-mode adders. Low Voltage Low-Power Multipliers Introduction, Overview of Multiplication, Types of Multiplier Architectures, Booth Multiplier, Wallace Tree Multiplier.

Low-Voltage, Low-Power Memories: Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Basics of SRAM, Memory Cell, Precharge and Equalization Circuit, Low-Power SRAM Technologies, Basics of DRAM, Self-Refresh Circuit, Future Trend and Development of DRAM

Text Books

1. Kiat-Seng Yeo, Kaushik Roy, Low-Voltage, Low-Power VLSI Subsystems –TMH Professional Engineering.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

2 Gary K. Yeap, Practical Low Power Digital VLSI Design –Kluwer Academic Press, 2002.

Reference Books

1 Rabaey, Pedram, "Low Power Design Methodologies" Kluwer Academic.

2 Kaushik Roy, Sharat Prasad, "Low-Power CMOS VLSI Circuit Design" Wiley.

3 Yeo, "CMOS/BiCMOS ULSI Low Voltage Low Power" Pearson Education.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram;
Guntur Dist., A.P. PIN: 522 502

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Annexure-IV

Y20 course structure for AY 2020-21 admitted batch.

S. NO	COURSE CODE	COURSE NAME	L	T	P	S	Cr	Pre requisites	Course Category (Employability / Entrepreneurship/ Skill development)	Activities / Content with direct bearing on Employability / Entrepreneurship/ Skill development	New Course (Yes/No)	Remarks
I	HUMANITIES & SOCIAL SCIENCES											
1	20UC1101	INTEGRATED PROFESSIONAL ENGLISH	0	0	4	0	2	NIL	EMPLOYABILITY / ENTREPRENEURSHIP	Practice based learning	No	
2	20UC1202	ENGLISH PROFICIENCY	0	0	4	0	2	NIL	EMPLOYABILITY / ENTREPRENEURSHIP	Practice based learning	No	
3	20UC2103	PROFESSIONAL COMMUNICATION SKILLS	0	0	4	0	2	NIL	EMPLOYABILITY / ENTREPRENEURSHIP	Practice based learning	No	
4	20UC2204	CORPORATE COMMUNICATION SKILLS	0	0	4	0	2	NIL	EMPLOYABILITY / ENTREPRENEURSHIP	Practice based learning	No	
5	20UC3005	APTITUDE BUILDER I	0	0	4	0	2	NIL	EMPLOYABILITY / ENTREPRENEURSHIP	Practice based learning	No	
6	20UC3006	APTITUDE BUILDER II	0	0	4	0	2	NIL	EMPLOYABILITY / ENTREPRENEURSHIP	Practice based learning	No	
7		FOREIGN LANGUAGE ELECTIVE	2	0	0	0	2	NIL	ENTREPRENEURSHIP	Case Studies based learning	No	
8	20UC0007	Indian Heritage and Culture	2	0	0	0	0	NIL	ENTREPRENEURSHIP	Case Studies based learning	No	

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
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9	20UC0008	Indian Constitution	2	0	0	0	0	NIL	ENTREPRENEURSHIP	Case Studies based learning	No	
10	20UC0009	Ecology & Environment	2	0	0	0	0	NIL	EMPLOYABILITY	Practice based learning	No	
11	20UC0010	Universal Human Values & Professional Ethics	2	0	0	0	0	NIL	ENTREPRENEURSHIP	Case Studies based learning	No	
12	20UC0011	Entrepreneurship	2	0	0	0	0	NIL	ENTREPRENEURSHIP	Case Studies based learning	No	
Total Credits							14					
II		BASIC SCIENCES										
1	20MT1101	MATHEMATICS FOR COMPUTING	2	2	0	2	4.5	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	
2	19MT2102	MATHEMATICS FOR ENGINEERS	2	1	0	0	3	NIL	EMPLOYABILITY	Practice based learning	No	
3	20UC1102	DESIGN THINKING AND INNOVATION I	1	0	0	4	2	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	
4	20UC1103	DESIGN THINKING AND INNOVATION II	1	0	0	4	2	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	
5	19BT1001	BIOLOGY FOR ENGINEERS	2	0	0	0	2	NIL	EMPLOYABILITY	Practice based learning	No	
Total Credits							13.5					

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Professor & Head
Department of ECE
KLEF
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

	SCIENCE ELECTIVE - 1											
1	19PH1008	PHYSICS FOR ELECTRONICS ENGINEERING	3	0	2	0	4	NIL	EMPLOYABILITY	Practice based learning	No	
2	19PH1004	SOLID STATE PHYSICS	3	0	2	0	4	NIL	EMPLOYABILITY	Practice based learning	No	
3	19PH2101	QUANTUM MECHANICS FOR ENGINEERS	3	1	0	0	4	NIL	EMPLOYABILITY	Practice based learning	No	
	SCIENCE ELECTIVE - 2											
1	19CY1101	ENGINEERING CHEMISTRY	3	0	2	0	4	NIL	EMPLOYABILITY	Practice based learning	No	
2	19CY1003	CHEMISTRY & BIOINFORMATICS FOR ENGINEERS	3	0	2	0	4	NIL	EMPLOYABILITY	Practice based learning	No	
3	19CY1004	ORGANIC ELECTRONICS	3	0	2	0	4	NIL	EMPLOYABILITY	Practice based learning	No	
Total Credits							8					
III	ENGINEERING SCIENCES											
1	**20SC1101**	COMPUTATIONAL THINKING FOR DESIGN	**3**	**0**	**2**	**6**	**5.5**	**NIL**	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	
2	20ME1103	DESIGN TOOLS WORKSHOP - I	0	0	4	0	2	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	
3	19SC1202	DATA STRUCTURES	3	0	2	4	5	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	

Dr. M. SUMA
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

4	19SC1209	DESIGN TOOLS WORKSHOP - II	0	0	4	0	2	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	
5	19SC1203	OBJECT ORIENTED PROGRAMMING	2	0	4	0	4	NIL	EMPLOYABILITY	Practice based learning	No	
6	20EC1101	DIGITAL LOGIC & PROCESSORS	3	0	2	0	4	NIL	EMPLOYABILITY	Practice based learning	No	
7	19EC1202	COMPUTER ORGANIZATION & ARCHITECTURE	2	0	0	0	2	20EC1101	EMPLOYABILITY	Practice based learning	No	
8	20EC1213	DESIGN of BASIC ELECTONIC CIRCUITS	3	0	0	0	3	NIL	EMPLOYABILITY	Practice based learning	No	
9	20EC2111	ELECTRONIC SYSTEM DESIGN WORKSHOP	1	0	2	2	2.5	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	
10	20EC2214	IOT Workshop	1	0	0	4	2	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	
11	20EC2112	IT Workshop	1	0	2	0	2	NIL	EMPLOYABILITY	Practice based learning	No	
Total Credits							34					
		PROFESSIONAL CORE COURSES										
1	19EC2103	Analog Electronic Circuit Design	3	0	2	2	4.5	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

2	19EC2104	Communication Signals & System Design	3	1	0	0	4	NIL	EMPLOYABILITY	Practice based learning	No	
3	19EC2105	Analog And Digital Communication	3	0	3	0	4.5	NIL	EMPLOYABILITY	Practice based learning	No	
4	20EC2106	Embedded Controllers & Embedded System Design	3	0	2	2	4.5	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	
5	19EC2207	Electromagnetic Fields & Applications	3	1	0	0	4	NIL	EMPLOYABILITY	Practice based learning	No	
6	19EC2208	Digital Signal Processing	3	0	2	0	4	NIL	EMPLOYABILITY	Practice based learning	No	
7	20EC2209 A	Statistics, AI & ANN	3	0	0	2	3.5	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	
8	20EC2209	AI, ANN Tools And Applications	3	0	0	0	3	NIL	EMPLOYABILITY	Practice based learning	No	
9	19EC2210	Data Networks And Protocols	3	0	2	0	4	NIL	EMPLOYABILITY	Practice based learning	No	
Total Credits							33					
SKILLING COURSES												
1	20TS3101	Technical Proficiency / Entrepreneurial Incubation	0	0	0	12	3	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	
2	20TS3202	Technical Proficiency / Technopreneurship	0	0	0	12	3	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	

M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P.

3	20TS4103	Technical Proficiency / Entrepreneurial Skilling	0	0	0	12	0	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No
4	20TS4204	Technical Proficiency / Entrepreneurial Skilling	0	0	0	12	0	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No
Total Credits							6				
TERM PAPER & PROJECT											
1	20IE2050	Social Internship	0	0	0	8	2	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No
2	20IE3050	Technical Internship	0	0	0	8	2	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No
3	20IE3150	Midgrade Capstone Project 1	0	0	0	8	2	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No
4	20IE3250	Midgrade Capstone Project 2	0	0	0	8	2	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No
5	20IE4150	Capstone Project 1	0	0	0	24	6	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No

Dr. M. SUMA...
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
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6	20IE4250	Capstone Project 2	0	0	0	24	6	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No
7	19IE4050	Practice School	0	0	0	24	6	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No
8	19IE4051	Internship	0	0	0	24	6	NIL	EMPLOYABILITY / SKILL DEVELOPMENT	Practice based learning, Problem Solving	No
Total Credits							20				
FLEXI-CORE											
1	FC-1	FLEXI-CORE-1					4		EMPLOYABILITY	Practice based learning	No
2	FC-2	FLEXI-CORE-2					4		EMPLOYABILITY	Practice based learning	No
3	FC-3	FLEXI-CORE-3					4		EMPLOYABILITY	Practice based learning	No
Total Credits							12				
OPEN ELECTIVES											
1	OE-1	OPEN ELECTIVE-1	3	0	0	0	3	NIL	EMPLOYABILITY	Practice based learning	No
2	OE-2	OPEN ELECTIVE-2	3	0	0	0	3	NIL	EMPLOYABILITY	Practice based learning	No
Total Credits							6				
PROFESSIONAL ELECTIVES											

Dr. M. SUMAN
Professor & Head
Department of ECE
KLEF
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1	PE-1	PROFESSIONAL ELECTIVE-1					3		EMPLOYABILITY	Practice based learning	No	
2	PE-2	PROFESSIONAL ELECTIVE-2					3		EMPLOYABILITY	Practice based learning	No	
3	PE-3	PROFESSIONAL ELECTIVE-3					3		EMPLOYABILITY	Practice based learning	No	
4	PE-4	PROFESSIONAL ELECTIVE-4					3		EMPLOYABILITY	Practice based learning	No	
5	PE-5	PROFESSIONAL ELECTIVE-5					3		EMPLOYABILITY	Practice based learning	No	
6	PE-6	PROFESSIONAL ELECTIVE-6					3		EMPLOYABILITY	Practice based learning	No	
Total Credits							18					
Grand Total Credits							**164.5**					

Flexi core courses

1	19EC3015	VLSI Design	3	0	2	0	4	NIL
2	19EC3016	Wireless Communications	3	0	2	0	4	NIL
3	19EC3017	RF System Design	3	0	2	0	4	NIL
4	19EC3018	Biomedical Electronics & Iot For Healthcare	3	0	2	0	4	NIL
5	19EC3019	Electronics Instruments & Automation	3	0	2	0	4	NIL
6	19EC3020	System Engineering, Operation Research & Designing	3	0	2	0	4	NIL
7	19EC3021	Electrical Technologies & Solar Power Systems	3	0	2	0	4	NIL
8	19EC3022	Advanced Course in Soft Computing (AI, ANN, Fuzzy Logic & Genetic Algorithms)	3	0	2	0	4	NIL
9	20EC3023	Database Management Systems	3	0	2	0	4	NIL

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
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Specialization Elective Courses

1	IOT	Module-1	Programming Technologies-C & Data Structure, Python	3	0	0	0	3	NIL
		Module-2	Introduction to IOT & IOT Platforms	3	0	0	0	3	NIL
		Module-3	Networking and Wireless Technologies	3	0	0	0	3	NIL
		Module-4	IoT Protocols	3	0	0	0	3	NIL
		Module-5	Edge, Cloud Computing and Analytics	3	0	0	0	3	NIL
2	VLSI	20EC3061	Low Power VLSI	3	0	0	0	3	NIL
		20EC3062	Algorithms for VLSI Design Automation	3	0	0	0	3	NIL
		20EC3063	ASIC & FPGA Chip Design	3	0	0	0	3	NIL
		20EC3064	VLSI Sub-system Design and Design for Testability	3	0	0	0	3	NIL
		20EC3065	Semiconductor Memories & MEMS	3	0	0	0	3	NIL
		20EC3066	Analog & Digital IC Applications	3	0	0	0	3	NIL
3	Renewable energy & Smart cities	20EC3051	Wireless sensor Networks & IOT Applications	3	0	0	0	3	NIL
		20EC3052	Solar Photo-Voltaic cells & Solar Power Arrays	3	0	0	0	3	NIL
		20EC3053	Electronic Systems for Renewable Energy & Smart Grid	3	0	0	0	3	NIL

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

		20EC3054	IOT Applications & Smart Cities	3	0	0	0	3	NIL
		20EC3055	Systems for Smart Cities & Smart Villages	3	0	0	0	3	NIL
4	SIGNAL PROCESSING	20EC3081	Speech Signal Processing	3	0	0	0	3	NIL
		20EC3082	Digital Image Processing	3	0	0	0	3	NIL
		20EC3083	Bio Medical Image Analysis	3	0	0	0	3	NIL
		20EC3084	Statistical Signal Processing	3	0	0	0	3	NIL
		20EC3085	Adaptive Signal Processing	3	0	0	0	3	NIL
		20EC3086	Detection and Estimation of Signals	3	0	0	0	3	NIL
		20EC3087	Bio Medical Signal Analysis	3	0	0	0	3	NIL
5	ROBOTICS & AUTOMATION	20EC3071	Control Systems & Introduction to Robotics	3	0	0	0	3	NIL
		20EC3072	Autonomous Vehicles & Automotive Electronics	3	0	0	0	3	NIL
		20EC3073	Advanced Robotics	3	0	0	0	3	NIL
		20EC3074	Computer Vision & Applications	3	0	0	0	3	NIL
		20EC3075	Human Machine Interface & Brain Machine Interface	3	0	0	0	3	NIL
		20EC3076	Designing Automation Systems & Assistive Robotic Systems	3	0	0	0	3	NIL
6		20EC4071	Automated Vehicles & Avionics	3	0	0	0	3	NIL

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

	BIO-MEDICAL INSTRUMENTATION	20EC4072	Calibrations and Designing Advanced Instruments	3	0	0	0	3	NIL
		20EC4073	Biological & Cyber-Physical Systems	3	0	0	0	3	NIL
		20EC4074	Electronic Instruments & Biomedical Applications	3	0	0	0	3	NIL
		20EC3072	Autonomous Vehicles & Automotive Electronics	3	0	0	0	3	NIL
		20EC3075	Human Machine Interface & Brain Machine Interface	3	0	0	0	3	NIL
7	RF & MICROWAVE	20EC3091	Microwave Engineering	3	0	0	0	3	NIL
		20EC3092	Antenna Design & Wave Propagation	3	0	0	0	3	NIL
		20EC3093	Radar Engineering & Navigational Aids	3	0	0	0	3	NIL
		20EC3094	Modern Antennas, Millimeter Waves & Applications	3	0	0	0	3	NIL
		20EC3095	Electronic Warfare, EMI & EMC	3	0	0	0	3	NIL
8	DATA COMMUNICATION	20EC4051	Information Theory & Coding	3	0	0	0	3	NIL
		20EC4052	4G Wireless Technologies & Cellular Communications	3	0	0	0	3	NIL
		20EC4053	Satellite Communications	3	0	0	0	3	NIL
		20EC4054	Optical Communication & Network	3	0	0	0	3	NIL
		20EC4055	Next Generation Wireless Technologies (WCDMA, GPRS, GSM, UMTS)	3	0	0	0	3	NIL

Dr. M. SURE...
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

		20EC4061	TCP/IP & Other Protocol Suite	3	0	0	0	3	NIL
		20EC4062	VoIP Systems & Broad Band Networks	3	0	0	0	3	NIL
		20EC4063	5G Mobile, Wireless Technologies & IEEE 802 Standards	3	0	0	0	3	NIL
		20EC4064	Cloud-Computing & Network Security	3	0	0	0	3	NIL
		20EC4065	IP Multimedia Sub-System & Emerging Technologies	3	0	0	0	3	NIL

Network Security, Data Science & Big Data, IOT, Artificial Intelligence & Machine Learning specializations are adapted from Dept of CSE.

Percentage of Syllabus Revision = (6/66) * 100 = 9.09 %

Percentage of Courses focusing on Employability = (61/66) * 100 = 92.42 %

Percentage of Courses focusing on Entrepreneurship = (11/66) * 100 = 16.67 %

Percentage of Courses focusing on Skill Development = (24/66) * 100 = 36.36 %

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Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
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Annexure-V

Y20 course structure for M. Tech VLSI AY 2020-21 admitted batch.

KLEF
Dept. of Electronics and Communication Engineering
M. Tech VLSI
Course Structure
AY. 2020-21

S. No.	Course Code	Name of the Course	L-T-P-S	Credits	Course Category (Employability / Entrepreneurship/ Skill development)	Activities / Content with direct bearing on Employability / Entrepreneurship/ Skill development	New Course (Yes/No)	Remarks
1.	20EC52T5	ADVANCED COMPUTER ARCHITECTURE DESIGN	3-0-0-0	2020-21	EMPLOYABILITY	Case Studies based learning	Yes	
2.	20EC5129	ANALOG IC DESIGN & DESIGN FOR TESTABILITY	2-2-2-0	5	SKILL DEVELOPMENT	Practice based learning, Problem Solving	Yes	
3.	20EC5130	ASIC & FPGA DESIGN	3-0-2-0	4	SKILL DEVELOPMENT	Practice based learning, Problem Solving	Yes	
4.	20EC52T4	CRYPTOGRAPHY AND NETWORK SECURITY	3-0-0-0	2020-21	EMPLOYABILITY	Case Studies based learning	Yes	

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

5.	20EC51R1	DEEP LEARNING WITH ARTIFICIAL INTELLIGENCE	3-0-0-0	2020-21	EMPLOYABILITY	Case Studies based learning	Yes	
6.	20EC5128	MOS CIRCUIT DESIGN	3-1-2-0	5	SKILL DEVELOPMENT	Practice based learning, Problem Solving	no	
7.	20EC52T3	NETWORK ON CHIP	3-0-0-0	2020-21	EMPLOYABILITY	Case Studies based learning	Yes	
8.	20EC52S5	RECONFIGURABLE COMPUTING	3-0-0-0	2020-21	EMPLOYABILITY	Case Studies based learning	Yes	
9.	20EC51R3	SEMICONDUCTOR DEVICE MODELING	3-0-0-0	3	EMPLOYABILITY	Case Studies based learning	No	
10.	20TS5101	TECHNICAL SKILLING-I (HDL)	0-0-0-8	2	SKILL DEVELOPMENT	Experimental Learning	Yes	
11.	20EC5235	TESTING OF VLSI CIRCUITS	3-0-0-0	3	SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	

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Professor & Head
Department of ECE
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12.	20EC51R5	VLSI CIRCUITS FOR BIO MEDICAL APPLICATIONS	3-0-0-0	2020-21	EMPLOYABILITY	Case Studies based learning	Yes	
13.	20EC52S2	VLSI DATA CONVERTORS	3-0-0-0	2020-21	EMPLOYABILITY	Case Studies based learning	Yes	
14.	20EC52S4	VLSI FOR WIRELESS COMMUNICATION	3-0-0-0	2020-21	EMPLOYABILITY	Case Studies based learning	Yes	
15.	20EC51Q2	VLSI SIGNAL PROCESSING	3-0-0-0	3	EMPLOYABILITY	Case Studies based learning	No	
16.	20EC52T2	ADVANCED DIGITAL IC DESIGN	3-0-0-0	3	EMPLOYABILITY, SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	
17.	20EC5234	ALGORITHM FOR VLSI DESIGN AUTOMATION	3-1-2-0	5	SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	
18.	20EC5131	IC FABRICATION TECHNOLOGY	3-0-0-0	3	EMPLOYABILITY, ENTREPRENEURSHIP	Problem based learning, Case study	No	

Dr. M. SUMAN
Professor & Head
Department of ECE
KLEF
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

19.	20EC5233	LOW POWER VLSI SYSTEM DESIGN	3-0-2-0	4	SKILL DEVELOPMENT	Practice based learning, Problem Solving	Yes	
20.	20EC52S3	MEMS SYSTEM DESIGN	3-0-0-0	3	SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	
21.	20EC5232	RF IC DESIGN & INTRODUCTION TO MM RADAR	3-1-2-0	5	SKILL DEVELOPMENT	Practice based learning, Problem Solving	Yes	
22.	20TS5202	TECHNICAL SKILLING-II (DESIGN FOR TESTABILITY)	0-0-0-8	2	SKILL DEVELOPMENT	Experimental Learning	No	

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

Percentage of Syllabus Revision = (14 /22) * 100 = 63.64 %

Percentage of Courses focusing on Employability = (12/22) * 100 = 54.55 %

Percentage of Courses focusing on Entrepreneurship = (1/22) * 100 = 4.54 %

Percentage of Courses focusing on Skill Development = (11/22) * 100 = 50 %

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Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

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Annexure-VI

Y20 course structure for M. Tech RADAR & Communications AY 2020-21 admitted batch.

KLEF **Dept. of Electronics and Communication Engineering** **M. Tech RADAR & Communications** **Course Structure** **AY. 2020-21**								
S. No.	**Course Code**	**Name of the Course**	**Semester (i.e. Odd / Even)**	**Year of introduction of course**	**Course Category (EMPLOYABILITY /SKILL DEVELOPMENT /ENTREPRENEURSHIP)**	**Activities/Content with direct bearing on Employability / Entrepreneurship/ Skill development**	**New Course (Yes/No)**	**Remarks**
1.	20EC5205	4G, 5G, AND MODERN WIRELESS TECHNOLOGIES	3-1-2-0	5	EMPLOYABILITY, ENTREPRENEURSHIP	Problem based learning, Case study	Yes	
2.	20EC5206	ADVANCED COMMUNICATION SYSTEMS & NETWORKS	3-1-0-0	4	EMPLOYABILITY, SKILL DEVELOPMENT	Practice based learning, Problem Solving	Yes	
3.	20EC52D4	AUTOMOTIVE ELECTRONICS AND AVIONICS	3-0-0-0	2020-21	EMPLOYABILITY	Practice based learning, Problem Solving	Yes	
4.	20EC52D2	CLOUD COMPUTING AND CYBER SECURITY	3-0-0-0	2020-21	EMPLOYABILITY	Practice based learning, Problem Solving	Yes	

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Professor & Head
Department of ECE
K L E F
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5.	20EC51A4	EMBEDDED SYSTEMS AND VLSI FOR WIRELESS	3-0-0-0	2020-21	EMPLOYABILITY	Practice based learning, Problem Solving	Yes	
6.	20EC51A1	EMI/EMC & ELECTRONIC WARFARE	3-0-0-0	3	EMPLOYABILITY	Practice based learning	Yes	
7.	20EC52C1	ESTIMATION & DETECTION THEORY	3-0-0-2	3.5	EMPLOYABILITY	Practice based learning	No	
8.	20EC51B2	GPS & GLOBAL NAVIGATION SATELLITE SYSTEM	3-0-0-0	3	EMPLOYABILITY	Problem based learning	No	
9.	20EC52D1	MACHINE LEARNING AND SOFT COMPUTING APPLICATIONS IN COMMUNICATION	3-0-0-0	2020-21	EMPLOYABILITY	Practice based learning, Problem Solving	Yes	
10.	20EC5102	MICROWAVE AND MILLIMETRIC WAVE CIRCUITS	3-1-2-0	5	SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	
11.	20EC5101	MODERN DIGITAL AND WIRELESS COMMUNICATION	3-1-2-0	5	SKILL DEVELOPMENT	Practice based learning, Problem Solving	Yes	
12.	20EC5207	MODERN RADAR SYSTEMS AND AUTONOMOUS VEHICLES	3-0-2-0	4	SKILL DEVELOPMENT	Practice based learning, Problem Solving	Yes	
13.	20EC51B3	NEXT GENERATION NETWORKING AND COMMUNICATION TECHNOLOGIES	3-0-0-0	2020-21	EMPLOYABILITY	Practice based learning, Problem Solving	Yes	

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Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
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14.	20EC5208	OPTICAL NETWORKS & SATELLITE COMMUNICATIONS	3-0-0-0	3	SKILL DEVELOPMENT	Practice based learning, Problem Solving	Yes	
15.	20EC5103	RADAR ENGINEERING & MM RADAR	3-0-0-0	3	SKILL DEVELOPMENT	Practice based learning, Problem Solving	Yes	
16.	20EC52D3	REMOTE SENSING & SENSORS	3-0-0-2	3.5	SKILL DEVELOPMENT	Practice based learning, Problem Solving	No	
17.	20EC5104	RF SYSTEM AND ANTENNA DESIGN	3-1-0-0	4	SKILL DEVELOPMENT	Practice based learning, Problem Solving	Yes	
18.	20IE5149	SEMINAR	0-0-4-0	2	EMPLOYABILITY	Practice based learning	No	
19.	20TS5203	TECHNICAL SKILLING-1 (MATLAB, AWR)	0-0-0-8	2020-21	SKILL DEVELOPMENT	Experimental Learning	Yes	
20.	20TS5204	TECHNICAL SKILLING-2 (MATLAB, AWR)	0-0-0-8	2	SKILL DEVELOPMENT	Experimental Learning	Yes	

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

Percentage of Syllabus Revision = (15/20) * 100 = 75 %

Percentage of Courses focusing on Employability = (11/20) *100 = 55 %

Percentage of Courses focusing on Entrepreneurship = (1/20) * 100 = 5 %

Percentage of Courses focusing on Skill Development = (10/20) *100 = 50 %

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
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ANALOG IC DESIGN & DESIGN FOR TESTABILITY

Course Code :20EC5129 **L-T-P-S: 3-2-2-0**
Pre-requisite: NIL **Credits: 5**
COURSE OUTCOMES (COs):

CO No	Course Outcome (CO)	PO/ PSO	Blooms Taxonomy Level (BTL)
CO1	Understand the basic working of MOS transistor and application of MOSFET for the realization of current mirrors and voltage reference.	PO1, PO3	2
CO2	Analysis and design of single stage amplifiers using MOSFET's	PO1, PO3	3
CO3	Analysis and realization of MOSFET operational amplifiers and their deviation from ideality.	PO3, PO4, PO5	3
CO4	Analyzing negative feedback in analog circuit and the analysis of non-linear analog circuits for practical application.	PO3, PO4, PO5	3
CO5	Design and analysis of analog circuits with the application of multiple circuit typologies and configurations using Mentor Graphics	PO2, PO3, PO5, PO6	3

Syllabus:

MOS Devices Modelling & Sub Circuits: Basics of MOSFET, enhancement mode operation, I-V characteristics and Transfer characteristics. Small Signal & large signal Models of MOSFET. MOS Switch, MOS Diode, MOS Active Resistor, Current Sinks and Sources, Basic Current Mirrors, Cascode current, Mirror and Wilson Current Mirror, Current and Voltage References, Band gap Reference **MOS Amplifiers:** Basic considerations of amplifier design, Single Stage (CS, CG, CD) amplifiers, Cascode Stage; Basic Differential Pair, Differential Amplifiers, Cascode Amplifiers, Differential pair with MOS loads, frequency response (miller effect) of CG, CS, CD. **CMOS Operational Amplifiers:** Design of CMOS Op Amps, Compensation of Op Amps, Design of Two-Stage Op Amps, Basic two-stage MOS operational amplifier, MOS Folded -Cascode operational amplifiers **Fault Tolerance & Modelling:** Basic concepts of fault tolerance, CMOS Fault models, testing of combinational logics, testing of sequential logics, scan design techniques. Fault Modelling, Failure modes in electronic components, Approximation modelling of analog integrated circuits. **Test Stimulus Generation:** Conventional analog test stimulus generation, Delta sigma (Δ-Σ) signal

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
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generation, Pseudorandom noise generation, Fault diagnosis procedure, Fault diagnosis procedure, Built-In-Self-Test (BIST), Design-fortestability approaches, Increased testability with test bus, Built-in-self-test.

Textbooks

1. Gray & Meyer, Analysis & Design of Analog Integrated Circuits, 4th edition, Wiley, 2001.
2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata Mcgraw Hill,2005.

Reference

1. Jacob Baker, "MOS Mixed Signal Circuit Design", John Wiley.
2. Gray, Wooley, Brodersen, " Analog MOS Integrated Circuits ", IEEE Press, 1989.
3. Kenneth R. Laker, Willy M.C. Sansen, William M. C. Sansen, "Design of Analog Integrated Circuits and Systems ", McGraw Hill.

MOOCS/Web Links:

https://onlinecourses.nptel.ac.in/noc20_ee26/preview

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
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Guntur Dist., A.P. PIN: 522 502

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ASIC & FPGA DESIGN

Course Code: 20EC5130 **L-T-P-S: 3-0-2-0**
Pre-requisite: NIL **Credits: 4**
COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Understand the different types of ASIC design methodologies and understand the basic coding concepts of digital system design, their modeling techniques in Verilog HDL.	PO1	2
CO2	Design and Analysis of various Combinational & Sequential Logic realizations using Verilog HDL.	PO2, PO3	4
CO3	Understand the concepts of Floor Planning, Placement and Routing Algorithms	PO1	2
CO4	Understand of different FPGA architectures.	PO1	2
CO5	Design and Analysis of digital modules through project-oriented approach	PO2, PO3, PO6	4

Syllabus:

Types of ASICs – Design flow – Economics of ASICs – ASIC cell libraries – CMOS logic cell- data path logic cells – I/O cells – cell compilers. Introduction to Verilog HDL: Basic concepts, Design modeling, Tasks and functions, Timing and delays. Synthesis of Combinational & Sequential Logic: Decoders and encoders, Multiplexers and Demultiplexers, Priority encoder, Priority decoder, Comparators, Adders, synthesis of three-state devices and bus interfaces, Latches & Flip-flops, counters, registers, finite state machines. Floor Planning & Placement& Routing: Floor Planning Goals and Objectives, Measurement of Delay in floor planning, Floor planning tools ,I/O and Power planning, Clock planning ,Placement Algorithms. Routing: Global routing, Detailed routing, special routing. Field Programmable Gate Arrays: Introduction, Basic Architecture, Design flow, Xilinx XC3000 & XC4000 Architectures, Actel Architectures, ALTERA's FLEX 8000, and ALTERA's FLEX 10000 FPGAs.

Text Books:

1. Application specific Integrated Circuits", J.S. Smith, Addison Wesley.

2. S.Trimberger, Edr., Field Programmable Gate Array Technology, Kluwer Academic Publications.

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Professor & Head
Department of ECE
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3. Michael D.Celetti "Advanced Digital Design with the Verilog HDL" Prentice Hall.

Reference Books:

1. Verilog Digital System Design RT Level synthesis Test Bench and verification by Zainalabedin Navabi, 2008 Mc Graw Hill Publishers

2. Stephen Brown Zvonko Vranesic "Fundamentals of Digital Logic with VHDL Design" McGraw-Hill.

MOOCS/Web Links:

https://www.mooc-list.com/tags/fpga-design

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
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DEEP LEARNING WITH ARTIFICIAL INTELLIGENCE

Course Code: 20EC51R1 **L-T-P-S: 3-0-0-0**
Pre-requisite: NIL **Credits: 3**

COURSE OUTCOMES (COs):

CO No	Course Outcome (CO)	PO/ PSO	Blooms Taxonomy Level (BTL)
CO1	To study the AI based VLSI design architecture	PO1, PO2	2
CO2	To understand the multi-Transputer, Architecture for a Parallel Logic Machine.	PO1, PO3	2
CO3	Ability to understand the VLSI analog and pulse stream neural network	PO4	2
CO4	Ability to implementation of neural network in VLSI	PO3, PO6	3

Syllabus:

ARCHITECTURE AND HARDWARE SUPPORT FOR AI PROCESSING: VLSI Design of a 3-D Highly PamUel Message-Passing Architecture - Design of the Rewrite Rule Machine Ensemble - Dataflow Architecture for AI - Incremental Garbage Collection Scheme in KLI and Its Architectural Support of PIM - COLIBRI - CAM Based Architecture for Production System Matching - SIMD Parallelism for Symbol Mapping - Logic Flow in Active Data. Unit II

MACHINES FOR PROLOG: Extended Prolog Instruction Set for RISC Processors - VLSI Engine for Structured Logic Programming - Performance Evaluation of a VLSI Associative Unifier in a WAM Based Environment - Parallel Incremental Architecture for Prolog Program Execution - An Architectural Characterization of Prolog Execution - Prolog abstract Machine for Content Addressable Memory - Multi-Transputer Architecture for a Parallel Logic Machine.

ANALOGUE AND PULSE STREAM NEURAL NETWORKS Computational Capabilities of Biologically Realistic Analog Processing Elements - Analog VLSI Models of Mean Field Networks - An Analogue Neuron Suitable for a Data Frame Architecture - Fully Cascadable Analogue Synapses Using Distributed Feedback - Results from Pulse-Stream VLSI Neural Network Devices - Working Analogue Pulse-Firing Neural Network Chips - An Analog Circuit with Digital I/O for Synchronous Boltzmann Machines.

DIGITAL IMPLEMENTATIONS OF NEURAL NETWORKS Cascadable VLSI Architecture for the Realization of Large Binary Associative Networks - Digital VLSI Implementations of an

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K L E F
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Associative Memory Based on Neural Networks - Probabilistic Bit Stream Neural Chip: Implementation - Binary Neural Network with Delayed Synapses - Syntactic Neural Networks in VLSI - VLSI Implementation of a Generic Systolic Synaptic Building Block for Neural Networks - Compact and Fast Silicon Implementation for Layered Neural Nets.

ARRAYS FOR NEURAL NETWORKS: Highly Parallel Digital Architecture for Neural Network Emulation - Delay-Insensitive Neural Network Engine - VLSI Implementation of Multi-Layered Neural Networks: Performance - Efficient Implementation of Massive Neural Networks - Implementing Neural Networks with the Associative String Processor.

Reference Book:

1. Jose G. Delgado-Frias, William R. Moore, "VLSI For Artificial Intelligence And Neural Networks", Springer Science Business Media, LLC, 2001.
2. Mohamed I. Elmasry, "VLSI Artificial Neural Networks Engineering", Springer Science Business Media, LLC, 2000.
3. Sied Mehdi Fakhraie, Kenneth C. Smith, "VLSI - Compatible Implementations for Artificial Neural Networks", Springer Science Business Media, LLC, 1996.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN- 522 502

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LOW POWER VLSI SYSTEM DESIGN

Course Code: 20EC5233 **L-T-P: 3-0-2-0**
Pre-requisite: NIL **Credits: 4**

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Understand the physics of power dissipation including short circuit power, dynamic power and leakage power, techniques that makes a low power circuit and introduction to simulation power analysis	PO1, PO2	2
CO2	Analyse probabilistic power analysis and apply low power techniques at circuit level for CMOS circuits	PO4, PO2	3
CO3	Apply low power techniques at gate level, architecture level and system levels	PO2, PO5	3
CO4	Understand essential tasks in algorithm and architecture level low power design environments and apply low power clock tree distribution techniques to create low power devices	PO2	2
CO5	Design of Various Low Power Circuits	PO3, PO5	4

Syllabus:

Introduction: Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches. Device & Technology Impact on Low Power: Dynamic dissipation in CMOS, Transistor sizing& gate oxide thickness, Impact of technology Scaling, Technology & Device innovation. Simulation Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation. Probabilistic power analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy. Low Power Circuit's: Transistor and gate sizing, network restructuring and Reorganization. Special Flip Flops & Latches design, high capacitance nodes, low power digital cells library. Logic level: Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic. Low power Architecture & Systems: Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components. Low power Clock Distribution: Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable

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skew, chip & package co design of clock network. Special Techniques: Power Reduction in Clock networks, CMOS Floating Node, Low Power Bus Delay balancing, and Low Power Techniques for SRAM.

Text Books:

1. Gary K. Yeap, "Practical Low Power Digital VLSI Design", KAP, 2002

2. Rabaey, Pedram, "Low Power Design Methodologies" Kluwer Academic

Reference Book:

1. Kaushik Roy, Sharat Prasad, "Low-Power CMOS VLSI Circuit Design" Wiley, 2000

2. Yeo, "CMOS/BiCMOS ULSI Low Voltage Low Power" Pearson Education

Dr. M. SUMAD
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502.

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RF IC DESIGN & INTRODUCTION TO MM RADAR

Course Code: 20EC5232 **L-T-P: 3-1-2-0**
Pre-requisite: NIL **Credits: 5**

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Understand the basics of RF system design and transmission media and reflection in passive components	PO1, PO3	2
CO2	Study and understanding the distributed systems and noise effects	PO5, PO3	2
CO3	Analysis and realization of voltage-controlled oscillators	PO3, PO5	4
CO4	Introduction to mm-wave RADAR and effect the of IC technology in the design of RADARs.	PO3, PO5	3
CO5	Analysis and study of standard functional blocks of communication systems at super-high frequencies	PO5, PO6, PO7	4

Syllabus:

Introduction to RF Design: Introduction to RF systems basic architectures, Nonlinearly and Time Variance, Inter symbol interference, random processes and noise. Sensitivity and dynamic range, conversion of gains and distortion. Transmission media and reflections: Maximum power transfer, Passive RLC Networks, Parallel RLC tank, Series RLC networks, matching, Pi match, T match, Passive IC Components, Interconnects and skin effect, Resistors, capacitors, Inductors, Review of MOS Device Physics, Operation of MOSFET at high frequencies

Distributed Systems: Transmission lines, reflection coefficient, The wave equation, examples Lossy transmission lines, Smith charts -- plotting gamma, High Frequency Amplifier Design Bandwidth estimation using open-circuit time constants, Bandwidth estimation using short-circuit time constants, Risetime, delay and bandwidth, Zeros to enhance bandwidth, Shunt-series amplifiers, tuned amplifiers, Cascaded amplifiers.

Noise: Thermal noise, flicker noise review, Noise figure, LNA Design, Intrinsic MOS noise parameters, Power match versus noise match, Large signal performance, design examples & Multiplier based mixers, Mixer Design, Subsampling mixers RF Power Amplifiers, Class A, AB, B, C amplifiers, Class D, E, F amplifiers, RF Power amplifier design examples. Voltage controlled oscillators: Resonators, Negative resistance oscillators, Phase locked loops, Linearized PLL models, Phase detectors, charge pumps, Loop filters, PLL design examples, Frequency synthesis and oscillators, Frequency division, integer-N synthesis, Fractional frequency synthesis, Phase noise

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Professor & Head
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General considerations, Circuit examples, Radio architectures, GSM radio architectures, CDMA, UMTS radio architectures, Passive on-chip components, Layout, Packaging & Testing. Introduction to mm RADAR: Introduction to RADAR principles, RADAR Sub-systems and Components: Transmitters, Receivers, Antennas, and IC Technology in RADAR systems. Introduction to millimeter length waves, Propagation and Scattering of Millimeter-Length Waves, mm wave RADARs and applications, Design considerations

Text Books:

1. B. Razavi, "RF Microelectronics" PHI 1998.

2. R. Jacob Baker, H.W. Li, D.E. Boyce "CMOS Circuit Design, layout and Simulation", PHI

3. Shao-Qiu Xiao, Ming-Tuo Zhou, and Yang Zhang "MILLIMETER WAVE TECHNOLOGY IN WIRELESS PAN, LAN, AND MAN," Chapter 10, Millimeter-Wave Radar: Principles and by Applications by Felix Yanovsky, CRC Press, Taylor & Francis Group 2008.

Reference Books:

1. The Design of CMOS Radio-Frequency Integrated Circuits by Thomas H. Lee. Cambridge University Press, 2004.

2. Y.P. Tsividis, "Mixed Analog and Digital Devices and Technology", TMH 1996.

3. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata Mcgraw Hill,2005.

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TECHNICAL SKILLING-I (HDL)

Course Code: 20TS5101 **L-T-P: 0-0-0-8**
Pre-requisite: NIL **Credits: 2**

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	To understand the basics of VLSI design with basics of Verilog programming	PO3	2
CO2	understand and apply concepts of combinational logic circuits in design and do a mini project	PO3	3
CO3	to understand and apply the concepts of sequential logic circuits in design and finally do a mini project	PO3	3
CO4	to understand the apply concepts of ASIC in doing a major project	PO3	3

Syllabus:

DIGITAL DESIGN USING VERILOG HDL Introduction to VLSI Design, VLSI Design Flow, Overview of Digital Design With Verilog HDL, Typical Design Flow, Popularity Of Verilog HDL, Importance Of HDLs. Introduction to EDA Tools, Xilinx Vivadio Tool, Simulation and Synthesis Process

Introduction to Verilog HDL Basic Concepts Lexical Conventions, Data Types, System Tasks, Compiler Directives. Modules and Ports Module Definition, Port Declaration, Connecting Ports, Hierarchical Name Referencing. Gate-Level Modeling Using Basic Verilog Gate Primitives, Examples For Combinational Circuits Dataflow Modeling Continuous Assignments, Delay Specification, Expressions, Operators, Operands, Operator Types. Behavioral Modeling Structured Procedures, Initial and Always, Blocking And Non-Blocking Statements, Delay Control, Generate Statement, Event Control, Conditional Statements CO 3 Sequential Circuits Design Using Verilog HDL- Flipflops, Shift Registers, Counters, Simulation And Synthesis Using Different Modellings CO 4 Introduction To FPGA, FPGA Design Flow, FPGA Dumping Process, Examples Interfacing With FPGA, ASIC Design Flow.

Text Books:

1.Micahel D.Ciletti, " advanced Digital Design with the verilog HDL ",Prentice Hall; Har/Cdr edition (30 August 2002)

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

2.samir Palnitkar ," Verilog Hdl, second edition, Pearson Publication.

3.J Baskar, " Verilog HDL Synthesis" (A practical Primer),Star Galaxy Publishing.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

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VLSI CIRCUITS FOR BIOMEDICAL APPLICATIONS

Course Code: 20EC51R5 **L-T-P-S: 3-0-0-0**
Pre-requisite: NIL **Credits: 3**

COURSE OUTCOMES (COs):

CO No	Course Outcome (CO)	PO/ PSO	Blooms Taxonomy Level (BTL)
CO1	To understand the neuro chemical sensing and its prototypes	PO3, PO4	2
CO2	Ability implements the CMOS circuits for implantable devices.	PO1, PO4	3
CO3	Ability to simulate the bio amplifier and neuro chemical recording	PO1, PO4	3
CO4	To understand the design strategies of neuro-mimetic IC and DNA Architectural optimizations	PO3, PO4	2

Syllabus:

Bio-Medical Sensing: Neuro chemical sensing-Neuro potential sensing- RF telemetry and Power harvesting in Implant devices Multimodal Electrical and Chemical Sensing-Prosthesis exterior body unit and wireless link-Body implantable unit system prototype.

CMOS Circuits for Biomedical Implantable Devices: Inductive link to deliver power implants- Data transmission through inductive links- Energy and Bandwidth issues in multi-channel recording-Strain Measurement and motivation for self-power sensing-Piezoelectric transduction and power delivery- Micro watt piezo powered electric circuits- Design and calibration of floating gate sensor Array.

CMOS Circuits for Wireless Medical Applications: Spectrum usage for medical Use- integrated transmitter and receiver architectures- radio architecture selection Low noise amplifiers- Mixers-Poly phase filters -Power Amplifiers and PLL.

Solid State Interface and Neural Stimulation: Micro needles – Types, Fabrication, Drug delivery and biosensing- Neural signal Recording and Amplifications-Neuro chemical Recording. Electrode configuration and tissue volume conductor, Electrode- Electrolyte interface- Efficacy of Neural

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

simulation - Stimulus generator architecture, Stimulation of front-end circuits- Bio-amplifier circuits and stimulation circuits.

Neuro-Mimetic IC, and Label Free Diagnostics: Neuron models for cell and network level- criteria and design strategies of neuro-mimetic IC - Fixed and Tunable model circuits. Label free molecular detection- Electrodes bio-functionalization, Bio chip application for DNA Architectural optimizations for Digital Microfluidic biochips- Magnetostatic bacteria as the functional component in CMOS microelectronic Systems.

Reference Book:

1. Krzysztof Iniewski, "VLSI Circuits for Biomedical Applications" Artech house Inc. 2008.
2. Rahul Sarpeshkar, "Ultra Low Power Bioelectronics: Fundamentals, Biomedical Applications and Bio-inspired Systems", Cambridge University Press, 2010.
3. E. Sanchez-Sinencio and A. G. Andreau "Low-voltage/Low-power Integrated Circuits and Systems", Wiley,1998.
4. Khandpur RS, "Handbook of Biomedical Instrumentation", McGraw Hill, New Delhi, 2014.

Dr. M. SUMAN
Professor & Head
Department of ECE
K. L. E. F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

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ADVANCED COMPUTER ARCHITECTURE DESIGN

Course Code :20EC52T5 **L-T-P-S: 3-0-0-0**
Pre-requisite: NIL **Credits: 3**

COURSE OUTCOMES (COs):

CO No	Course Outcome (CO)	PO/ PSO	Blooms Taxonomy Level (BTL)
CO1	To understanding the principles of parallel processing and processor.	PO1, PO4	2
CO2	Ability to demonstrate the knowledge of memory organisations and pipeline architecture	PO1, PO4	3
CO3	To analyze the multi thread and dataflow architecture	PO3, PO6	3
CO4	To understand the parallel processing programming	PO1, PO4	3

Syllabus:

Principles of Parallel Processing: Multiprocessors and Multi computers – Multi vector and SIMD Computers – PRAM and VLSI Models – Conditions of Parallelism – Program Partitioning and Scheduling –Program Flow mechanisms – Parallel Processing applications – Speed up Performance Law.

Processor and Memory Organization: Advanced Processor Technology – Superscalar and Vector Processors – Memory hierarchy technology – Virtual Memory technology – Cache Memory Organization – Shared Memory Organization.

Pipeline and Parallel Architecture: Linear Pipeline Processors – Non-Linear Pipeline processors – Instruction pipeline design – Arithmetic design – Superscalar and Super Pipeline design – Multiprocessor system interconnects – Message passing mechanisms.

Vector– Multithread and Dataflow Architecture: Vector Processing principle – Multi vector Multiprocessors – Compound Vector processing – Principles of Multithreading – Fine Grain Multi computers – Scalable and Multithread Architectures – Dataflow and Hybrid Architectures.

Software and Parallel Processing: Parallel programming models – Parallel languages and Compilers – Parallel programming environments – Synchronization and Multiprocessing modes – Message Passing program development – Mapping programs onto Multi computers

Reference Book:

1. Kai Hwang- Advanced Computer Architecture- TMH 2013.

Dr. M. SUMAN
Professor & Head
Department of ECE
K. L. E. F.
Green Fields, Vaddeswara
Guntur Dist., A.P. PIN: 522 5

2. William Stallings, "Computer Organization and Architecture", McMillan Publishing Company, 2013.
3. M.J. Quinn, "Designing efficient Algorithms for parallel computer", McGraw Hill International, 1994.
4. Hesham El-Rewini and Mostafa Abd-El-Barr, "Advanced Computer Architecture and Parallel Processing", John Wiley and sons, 2005.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

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CRYPTOGRAPHY AND NETWORK SECURITY

Course Code :20EC52T4 **L-T-P: 3-0-0**
Pre-requisite: NIL **Credits: 3**

COURSE OUTCOMES (COs):

CO No	Course Outcome (CO)	PO/ PSO	Blooms Taxonomy Level (BTL)
CO1	To understand the cryptography schemes and reconfigurable hardware.	PO1, PO2, PO6	2
CO2	To understand the finite field arithmetic and algorithms	PO1PO2	2
CO3	To analyse the decoder architecture	PO2, PO4	3
CO4	To analyse the advanced encryption standard.	PO1, PO4	3

Syllabus:

Modern Cryptography and Reconfigurable Hardware Technology: Secret Key Cryptography, Hash Functions, Public Key Cryptography, Digital Signature Schemes, Cryptographic Security Strength, Potential Cryptographic Applications, Fundamental Operations for Cryptographic Algorithms, FPGA Platforms versus ASIC and General, Purpose Processor Platforms, Reconfigurable Computing Paradigm, Implementation Aspects, FPGA Architecture Statistics, Security in Reconfigurable Hardware Devices.

Prime Finite Field Arithmetic: Finite Fields, Elliptic curves, Elliptic curves over GF, Point and scalar Representation, Addition operation, modular binary operation, omura's method, modular multiplication operation, brickells method, Montgomery's method modular exponential operation, binary strategies-window strategy.

Binary Finite Field Arithmetic: Field multiplication, Multipliers, Comparison of field multiplier designs, field squaring and field square root for irreducible trinomials, multiplicative inverse, The Itoh, Tsujii algorithm, ITMIA algorithm, Square Root ITMIA, other arithmetic operations, Trace function, Quadratic Equation over GF, Exponentiation over Binary Finite Fields.

Sphere Decoder Architecture: Reduced Complexity, SDA, Sorting architecture, Combination of SDA and Merge sorting, Comprehensive complexity Analysis, Conventional Sphere Decoder architecture, Parallel and Pipeline Interleaved Sphere Decoder, Early Pruning K- best sphere decoder, List Sphere decoder, Fast Radius Updating Architecture.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

Block Ciphers in FPGA's and Advanced Encryption: Standard Block ciphers, data encryption standard, FPGA implementation of DES algorithm, other DES algorithms, Rijindael algorithm, AES in different modes, implementing AES round based transformations on FPGA's, Performance, Hessian form, Scalar multiplication on Reconfigurable Hardware, Koblitz Curves.

Reference Book:

1. Cryptography and Network Security, William Stallings, Pearson Education, Noida, 2012.
2. Francisco Rodriguez-Henrique and Harris, Cryptographic algorithms on Reconfigurable Hardware, Springer 2006.
3. Qingwei Li, Efficient VLSI Architectures for MIMO and Cryptography Systems, ProQuest, UMI Dissertation Publishing, 2011.
4. Trappe, Wade & Washington Lawrence C, Introduction to Cryptography with Coding Theory, Pearson Education, Noida, 2011.
5. Forouzan, Behrouz A, Data Communications and Networking, McGraw-Hill Publications, 2013.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

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NETWORK ON CHIP

Course Code :20EC52T3 **L-T-P-S: 3-0-0-0**
Pre-requisite: NIL **Credits: 3**

COURSE OUTCOMES (COs):

CO No	Course Outcome (CO)	PO/ PSO	Blooms Taxonomy Level (BTL)
CO1	To understand the Network on-chips architecture and protocols	PO1, PO7	2
CO2	Ability to analyse the NoC fault tolerance	PO1, PO3	3
CO3	To understand the energy and power issues of NOC	PO1, PO2, PO3	2
CO4	Ability to analyse the micro architecture of NOC router and 3D NOC	PO2, PO5	3

Syllabus:

INTRODUCTION TO THREE DIMENSIONAL NOC: Three-Dimensional Networks-on-Chips Architectures. – Resource Allocation for QoS On Chip Communication – Networks-on-Chip Protocols-On-Chip Processor Traffic Modeling for Networks-on- Chip

TEST AND FAULT TOLERANCE OF NOC: Design-Security in Networks-on-Chips-Formal Verification of Communications in Networks-on-Chips- Test and Fault Tolerance for Networks-on-Chip Infrastructures-Monitoring Services for Networks-on- Chips.

ENERGY AND POWER ISSUES OF NOC: Energy and Power Issues in Networks-on-Chips-The CHAIN works Tool Suite: A Complete Industrial Design Flow for Networks-on Chips

MICRO-ARCHITECTURE OF NOC ROUTER Baseline NoC Architecture – MICRO-Architecture Exploration ViChaR: A Dynamic Virtual Channel Regulator for NoC Routers- RoCo: The Row-Column Decoupled Router – A Gracefully Degrading and Energy-Efficient Modular Router Architecture for On-Chip Networks. Exploring Fault Tolerant Networks-onChip Architectures.

DIMDE ROUTER FOR 3D NOC: A Novel Dimensionally-Decomposed Router for On-Chip Communication in 3D Architectures-Digest of Additional NoC Macro-Architectural Research.

Reference Book:

1. Chrysostomos Nicopoulos, Vijaykrishnan Narayanan, Chita R.Das" Networks-on - Chip " Architectures A Holistic Design Exploration", Springer.
2. Fayezgebali, Haythamelmiligi, Hqhahed Watheq E1-Kharashi "Networks-on-Chips theory and practice CRC press.

Dr. M. SUMAN
Professor & Head
Department of ECE
KLEF
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

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Phone No. 08645 - 350200, www.klef.ac.in; www.klef.edu.in; www.kluniversity.in
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RECONFIGURABLE COMPUTING

Course code 20EC52S5 **L-T-P-S: 3-0-0-0**
Pre-requisite: NIL **Credits: 3**

COURSE OUTCOMES (COs):

CO No	Course Outcome (CO)	PO/ PSO	Blooms Taxonomy Level (BTL)
CO1	To understand the reconfigurable architectures and systems, Supercomputing	PO1, PO3	2
CO2	To Understand the management of reconfigurable system	PO1, PO3	2
CO3	To Understand the implementation issues on reconfigure platforms	PO1, PO3	2
CO4	To analyse the Reconfigurable Hardware Applications	PO1, PO3	3

Syllabus:

RECONFIGURABLE ARCHITECTURES AND SYSTEMS Computational Fabric, Array and Interconnects, Extending logic, Configuration, Architectures- Fine and Coarse grained with and without processors. Systems PAM, VC, Splash, Prism, CAL, Cloning, Accelerating Technology – Teramac, Reconfigurable Supercomputing- Cray, SRC, Silicon Graphics, CMX.

RECONFIGURATION MANAGEMENT Configuration Architectures, Managing the Reconfiguration Process, Reducing Configuration Transfer time, Computing Models and System Architectures- Computing C for Spatial Computing, Operating System Support for Reconfigurable Computing- Flexible Binding, Scheduling, Preemption Communication Synchronization

IMPLEMENTATION ISSUES ON RECONFIGURABLE PLATFORMS: Structural Mapping Algorithms, Integrated Mapping Algorithms, Mapping Algorithms for Heterogeneous Resources. FPGA Placement- FPGA Placement Problem, Clustering Simulated Annealing for Placement, Partition-based Placement, Analytic Placement Data path Composition- Fundamentals, Impact of Device Architecture, Interface to Module Generators, Mapping, Placement, Compaction

APPLICATION DEVELOPMENT Retiming, Re-pipelining, and C-slow Retiming- Configuration Bit stream Generation- Downloading Mechanisms, Instance-specific Design, Partial Evaluation, Precision Analysis for Fixed-point Computation, Hardware/Software Partitioning

CASE STUDIES OF FPGA APPLICATIONS SPIHT Image Compression, Automatic Target Recognition Systems on Reconfigurable Devices, Multi-FPGA Systems, Network Packet Processing in Reconfigurable Hardware Bioinformatics Applications - Dynamic Programming Algorithms- Seed-Based Heuristics. Profiles, HMMs and Language Models. Bioinformatics FPGA Accelerators.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswara
Guntur Dist., A.P. PIN: 522

Reference Book:

1. Hauck & DeHon . "Reconfigurable Computing, 1st Edition-The Theory and Practice of FPGA-Based Computation", Elsevier India Private Limited, New Delhi, 2011.
2. Gokhale, Maya B., Graham, Paul S., "Reconfigurable Computing -Accelerating Computation with Field Programmable Gate Arrays" Springer Publications 2007.
3. Joao Cardoso and Michael Hübner, "Reconfigurable Computing: From FPGAs to Hardware/Software Codesign", Springer Publications, 2011.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

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VLSI DATA CONVERTERS

Course Code :20EC52S2 **L-T-P -S: 3-0-0-0**
Pre-requisite: NIL **Credits: 3**

COURSE OUTCOMES (COs):

CO No	Course Outcome (CO)	PO/ PSO	Blooms Taxonomy Level (BTL)
CO1	To understand the data converters and its specifications	PO1, PO3	2
CO2	Able to Design D/A converters and circuits for data converters using CMOS	PO3, PO5	3
CO3	Able to Design the Nyquist rate A/D converters and circuits.	PO3, PO5	3
CO4	Ability to Analyse the Technique testing of ADC & DAC	PO3, PO4, PO5	3

Syllabus:

INTRODUCTION TO DATA CONVERTERS AND ITS SPECIFICATIONS: Ideal converter-sampling-amplitude quantization-KT/C- discrete and fast Fourier transform- coding schemes-D/A converters-Z transform- type of converter-Condition of operation converter specifications: static and dynamic specification, digital and switching specification.

NYQUIST RATE D/A CONVERTERS AND CIRCUITS FOR DATA CONVERTERS: Types of converters-resistor based architectures- capacitor based architectures- current source-based architectures other architectures. Sample and hold- diode bridge S&H- switched emitter follower-features of Sample and Hold with BJT's-CMOS Sample and Hold -CMOS switch with low voltage supply- folding converters- Voltage to Current converters- clock generation

NYQUIST RATE A/D CONVERTERS: Timing accuracy-full flash converters-sub ranging and two step converters-folding and interpolation-time interleaved converters-successive approximation-pipeline-other architectures **OVER SAMPLING AND LOW ORDER, HIGHER ORDER, EΔ MODULATORS:** Noise shaping - first order modulator - second order modulator - circuit design issues-architecture design issues. SNR enhancement- higher order noise shaping- continuous time sigma delta modulators – band pass sigma delta modulators over sampling DAC.

DIGITAL ENHANCEMENT TECHNIQUES AND TESTING OF ADC & DAC: Error measurement - trimming elements-foreground calibration -background calibration - dynamic matching - decimation - interpolation - test board - quality and reliability- data processing static DAC testing - dynamic DAC testing- static and dynamic ADC testing.

Reference Book:

Dr. M. SUMAN
Professor & Head
Department of ECE

1. Franco Maloberti, "Data Converters", springer, 2012.
2. Gabriele Manganaro, "Advanced data Converters" Cambridge, Newyork,2012.
3. Mikael Gustavsson, J. Jacob Wikner, Nianxiong Tan, "CMOS data converters for communications", The International Series in Engineering and Computer Science Volume 543, 2008.
4. George Burbridge Clayton "Data converters", Wiley, 2005.
5. Behzad Razavi, Principles of Data Conversion System Design, Wiley-IEEE Press, 1995
6. Rudy J. van de Plassche, CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters, Springer, 2003

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

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VLSI FOR WIRELESS COMMUNICATION

Course code: 20EC52S4 **L-T-P-S : 3-0-0-0**
Pre-requisite: NIL **Credits: 3**

COURSE OUTCOMES (COs):

CO No	Course Outcome (CO)	PO/ PSO	Blooms Taxonomy Level (BTL)
CO1	Understanding the wireless communications systems	PO1, PO3	2
CO2	Understand the Low noise amplifier design for VLSI wireless communication	PO1, PO3	2
CO3	Ability to understand the design of Passive Mixer	PO3, PO5	2
CO4	To Understand and design the various types of Analog-to-Digital Converters	PO3, PO5	3

Syllabus:

Communication Concepts: Wireless Channel Description, Path Loss, Multipath Fading, Channel Model and Envelope Fading, Frequency Selective and Fast Fading

Receiver Architectures: Receiver Front End: Filter Design, Rest of Receiver Front End, Derivation of NF, IIP3 of Receiver Front End,

Low Noise Amplifier: Wideband LNA Design, Narrow Band LNA: Impedance Matching, Core Amplifier **Active Mixer**: Balancing, Qualitative Description of the Gilbert Mixer, Distortion, Low Frequency Case: Analysis of Gilbert Mixer, Distortion, High-Frequency Case, Noise

Passive Mixer: Switching Mixer, Distortion in Unbalanced Switching Mixer, Conversion Gain in Unbalanced Switching Mixer, Noise in Unbalanced Switching Mixer, practical Unbalanced Switching Mixer, Sampling Mixer, Conversion Gain in Single-Ended Sampling Mixer

Analog-to-Digital Converters: Demodulators, A/D converters Used in a Receiver, Low-Pass Sigma-Delta Modulators, Implementation of Low-Pass Sigma-Delta Modulators, Bandpass Sigma-Delta Modulators, Implementation of Bandpass Sigma-Delta Modulators

Textbook

1. Bosco Leung, "VLSI for Wireless Communication, Second Edition, Springer

References

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 50

1. Emad N Farag, M.I Elmasry, "Mixed Signal VLSI Wireless Design Circuits and Systems", Kluwer Publication.

2. David Tsee, Pramod Viswanath," Fundamentals of Wireless Communication", Cambridge Univ Press.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaran,
Guntur Dist., A.P. PIN: 522 502

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Phone No. 08645 - 350200, www.kluniversity.in
Admin Off: 29-30-36, Museum Road, Governorpet, Vijayawada - 520 002. Ph: +91 - 866 - 3500122, 2577715, 2570129

ADVANCED COMMUNICATION SYSTEMS & NETWORKS

Course Code: 20EC5206 **L-T-P: 3-1-0-0**
Pre-requisite: NIL **Credits: 4**

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Advanced Wireless Communication Spectrum sharing: Revolution of Wireless Spectrum (RWS) – principle advanced spectrum allocations (ASA)-Long Term Evolution spectrum (LTE) – Understanding LTE band 8 spectrums - Spectrum in 5G cellular mobile services- Spectrum allocations below 6GHz- 5G the MM-Wave band- fundamental roadblock Visible Light Communications- Machine-to-Machine (M2M) communication- Machine-Type Communication- Machine -Type Devices (MTD)	PO1, PO5, PO6	1
CO2	Massive MU-MIMO System- The fundamentals of MU-MIMO diversity and multiplexing gains, beam forming gain, SDMA based multi user system - Vertical Bell Lab layered space-time (V-BLAST), space-time block codes (STBCs), Linear dispersion codes (LDCs), spatial modulation (SM) and space-shift keying (SSK), and space-time shift keying (STSK)	PO3	2
CO3	Wireless Systems and Networks in Automation & Paradigms for Advanced Wireless Networks (PAWN)	PO3	2
CO4	Cryptography and Cryptanalysis- Secure Coding Principles and Practices-Advanced Encryption Standard (AES), Introduction to Public Key Cryptosystem, Diffie-Hellman Key Exchange, Knapsack Cryptosystem, RSA Cryptosystem. Cryptographic Hash Function, Secure Hash Algorithm (SHA), Digital Signature Standard (DSS). Side-channel attack, The Secure Sockets Layer (SSL), Pretty Good Privacy (PGP)	PO1, PO7	2

Syllabus:

Advanced Wireless Communication Spectrum sharing: Revolution of Wireless Spectrum (RWS) – principle advanced spectrum allocations (ASA)-Long Term Evolution spectrum (LTE) – Understanding LTE band 8 spectrums - Spectrum in 5G cellular mobile services- Spectrum allocations below 6GHz- 5G the MM-Wave band- fundamental roadblock Visible Light

M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

Communications-Machine-to-Machine (M2M) communication- Machine-Type Communication-Machine-Type Devices (MTD)

Massive MU-MIMO System- The fundamentals of MU-MIMO diversity and multiplexing gains, beam forming gain, SDMA based multi user system - Vertical Bell Lab layered space-time (V-BLAST), space-time block codes (STBCs), Linear dispersion codes (LDCs), spatial modulation (SM) and space-shift keying (SSK), and space-time shift keying (STSK) Spectral Efficiency: SNR and bit/symbol energy, error probability for Index Modulation (IM) , OFDM with Index Modulation(OFDM-IM) -FBMC/OQAM modulation- Single-carrier modulations (SCMs)-Faster-than-SyQuest (FTN)- Time-frequency-packed (TFS) Signaling-TFS with QAM and OQAM. Orthogonal Time Frequency and Space (OTFS); Case Studies_1 Design Issues towards 5G and 6G Wireless Networks

Wireless Systems and Networks in Automation: Functionality, Architecture of V2I (Vehicle-to-infrastructure), V2V (Vehicle-to-vehicle), V2P (Vehicle-to-pedestrian), V2D (Vehicle-to-device), and V2G (Vehicle-to-grid)- DSRC Dedicated Short Range Wireless Communication and C-V2X Integration. Paradigms for Advanced Wireless Networks (PAWN): Dynamic network architecture- User-centric spectrum sharing in wireless networks- Dynamic network slicing for flexible radio access in Tactile Internet- Highly context-aware resource allocation schemes for future wireless networks- Novel RAN Architectures

Cryptography and Cryptanalysis- Secure Coding Principles and Practices-Advanced Encryption Standard (AES), Introduction to Public Key Cryptosystem, Diffie-Hellman Key Exchange, Knapsack Cryptosystem, RSA Cryptosystem. Cryptographic Hash Function, Secure Hash Algorithm (SHA), Digital Signature Standard (DSS). Side-channel attack, The Secure Sockets Layer (SSL), Pretty Good Privacy (PGP), Case Studies 2: Quantum Communications System, quantum Internet, Quantum Cryptography of Amazon, IBM and Microsoft race to bring global access to quantum computing

Text Books:

1. Kshetrimayum, Rakhesh Singh. Fundamentals of MIMO Wireless Communications. India: Cambridge University Press, 2017.
2. Vehicular Communications and Networks: Architectures, Protocols, Operation and Deployment. Netherlands: Elsevier Science, 2015.
3. Cryptography and Network Security (SIE). India: Tata Mcgraw Hill Education Private Limited, 2011.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram.
Guntur Dist., A.P. PIN: 522 50

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Admin Off: 29.36.38, Museum Road, Governorpet, Vijayawada - 520 002. Ph: +91 - 866 - 3500122, 2577715, 2576129

AUTOMOTIVE ELECTRONICS & AVIONICS

Course Code: 20EC52D4 **L-T-P-S: 3-0-0-0**
Pre-requisite: NIL **Credits**: 3

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Understand and recognize various control systems, sensors, engine construction and its associated subsystems as well as standard environment parameters for the functioning of an automotive	PO1, PO5, PO6	1
CO2	Understanding the various safety monitoring controls and the electronics behind the alert systems in Automated Vehicle Assisting systems	PO3	2
CO3	Identifying and interpreting the technology behind autonomous vehicles.	PO3	2
CO4	Understanding the various electronics systems integrated in avionics for the development of autonomous flight and control operations.	PO1, PO7	2

Syllabus

Introduction to Automotive Engineering: Control systems, Vehicle component nomenclature, sensors and instrumentation, introduction to avionics. • Automotive Electronics: Different types of vehicle parameters, basic construction detail of engine, transmission and suspension systems, Engine Electronics, Transmission Electronics, • Sensors: Engine speed sensor, Atmospheric pressure and air temperature sensor, Steering system and steering wheel sensor, Oxygen sensor, MAP sensor, MAF sensor, Crankshaft and Cam Shaft position sensor, Coolant temperature sensor, safety sensors.

Automated Vehicle Assisting systems: Active Safety System, Passive Safety System, ADAS, Functional Safety. • Active Safety Systems: Anti-Lock Braking System, Traction Control System, Electronic Stability Control ESC, Brake assist. • Passive Safety Systems: Airbag systems, Seat Belt, Occupant Safety System, Child Safety System, Pedestrian Air Bag System. • Advanced Driver Assistance Systems (ADAS): Adaptive Cruise Control ACC, Adaptive Light Control ALC, Blind Spot Monitor, Collision Avoid Monitor, Driver Monitoring System DMS, Lane Change Assistance, Pedestrian Protection system, Tire Pressure monitoring, Traffic Sign Recognition, wrong way driving warning, Automatic Parking system.

Autonomous Vehicles Technologies: Remote Sensing and Wireless Technology, Automated Vehicle Technology, Vehicle Intelligence. • Remote Sensing and Wireless Technology: Radar and

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswara
Guntur Dist., A.P. PIN: 522

Sonar, Lidar- Multiple Beam, Camera and Night Vision, Wireless System, Integration of GPS technology. • Automated Vehicle Technology: Driverless Vehicle Technology, Navigation System, V2V, V2R, V2I communication, AI and ML.

Avionics: Introduction, Construction and Working and Indication System. • Introduction: Construction of aircraft, UAV, RPV. • Flight control systems: Airspeed Indicator, Attitude Indicator, Compass system, Gyroscopic system, heading indicator, Turning indicator, Flight director systems, Navigation systems, Auto Pilot System, Very-High Frequency Omnidirectional Range (VOR), Non-directional Radio Beacon (NDB)

Textbooks

1. Williams. B. Ribbens: "Understanding Automotive Electronics", 6th Edition, Elsevier Science, Newnes Publication, 2003.

2. Robert Bosch: "Automotive Electronics Handbook", John Wiley and Sons, 2004.

Reference books

1. Ronald K Jurgen: "Automotive Electronics Handbook", 2nd Edition, McGraw-Hill, 1999.

2. James D. Halderman: "Automotive Electricity and Electronics", PHI Publication.

3. Slater J.M., Donnel C.F.O, Onertial Navigation analysis and design, McGraw Hill, New York, 1964.

4. Myron Kyton, Walfred Fried, Avionics Navigation systems, 2nd edition, John Willy & Sons, 1997.

5. Albert D Helfrick, Modern Aviation Electronics: 2nd Ed., PHI, 1994.

6. John S. Duncan, "Pilots handbook of Aeronautical Knowledge", federal Aviation administration.

7. Jack Erjavec, "A systems Approach to Automotive Technology", Cengage learning India Pvt. Ltd.

8. William H Crouse, "Automotive Mechanics", 10th edition, Mc Graw Hill.

9. Dr. Kripal Singh, "Automobile Engineering", Vol.1&2, Standard Publishers.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram.
Guntur Dist., A.P. PIN: 522 502

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Campus: Green Fields, Vaddeswaram - 522 302, Guntur District, Andhra Pradesh, INDIA
Phone No. 08645 - 350200; www.kluniversity.in
Admin Off: 29-36-38, Museum Road, Governorpet, Vijayawada - 520 002, Ph: +91 - 866 - 3500122, 2577715, 2570129

CLOUD COMPUTING & CYBER SECURITY

Course Code: 20EC52D2 **L-T-P-S: 3-0-0-0**
Pre-requisite: NIL **Credits**: 3

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Identify the appropriate cloud services for a given application	PO6	3
CO2	Analyze Cloud infrastructure including Google Cloud and Amazon Cloud.	PSO2	4
CO3	Analyze authentication, confidentiality, and privacy issues in Cloud computing environment.	PSO1	4
CO4	Determine financial and technological implications for selecting cloud computing platforms, Introduction to Computer Network, cryptography, Cybersecurity, Application Security – Penetration Testing	PSO1	4

Syllabus:

Cloud Computing Basics-Overview, Applications, Intranets and the Cloud. Your Organization and Cloud Computing- Benefits, Limitations, Security Concerns. Hardware and Infrastructure- Clients, Security, Network, Services. Software as a Service (SaaS)- Understanding the Multitenant Nature of SaaS Solutions, Understanding SOA.Platform as a Service (PaaS)-IT Evolution Leading to the Cloud, Benefits of PaaSolutions, Disadvantages of PaaS Solutions. Infrastructure as a Service (IaaS)-Understanding IaaS, Improving Performance through Load Balancing, System and Storage Redundancy, Utilizing Cloud-Based NAS Devices, Advantages, Server Types. Identity as a Service (IDaaS)- Understanding Single Sign-On (SSO), OpenID, Mobile ID Management. Cloud Storage-Overview, Cloud Storage Providers. Virtualization-Understanding Virtualization, History, Leveraging Blade Servers, Server Virtualization, Data Storage Virtualization. Securing the Cloud-General Security Advantages of Cloud-Based Solutions, Introducing Business Continuity and Disaster Recovery. Application Scalability-Load-Balancing Process, Designing for Scalability, Capacity Planning Versus Scalability, Scalability and Diminishing Returns and Performance Tuning. Introduction of Computer Network and Cryptography, Introduction to Cybersecurity, Application Security – Penetration Testing, Fortinet NSE1: Information Security Awareness, Fortinet NSE2: Evolution of Cybersecurity, Fortinet NSE4: Evolution of Cybersecurity

Text Books:

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram.
Guntur Dist., A.P. PIN: 522 502

1. Anthony T. Velte Toby J. Velte, Robert Elsenpeter," Cloud Computing: A Practical Approach", McGraw-Hill, (2010).
2. Dr. Kris Jamsa," Cloud Computing: SaaS, PaaS, IaaS, Virtualization and more".
3. Cyber Security Engineering by Mead and Woody

Reference Books:

1. Frank H. P. Fitzek, Marcos D. Katz, "Mobile Clouds: Exploiting Distributed Resources in Wireless, Mobile and Social Networks", Wiley Publications, ISBN: 978-0-470-97389-9, (2014).
2. Jason Venner, "Pro Hadoop- Build Scalable, Distributed Applications in the Cloud", A Press, (2009).
3. Tom White, "Hadoop The Definitive Guide", First Edition. O'Reilly, 2009.
4. Judith Hurwitz, Robin Bloor, Marcia Kaufman, and Dr. Fern Halper, "Cloud Computing for Dummies" Wiley Publishing, (2010).
5. Dinakar Sitaram, "Moving to The Cloud", Elsevier ,(2014).

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

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EMBEDDED SYSTEMS & VLSI FOR WIRELESS COMMUNICATION

Course Code: 20EC51A4 **L-T-P-S: 3-0-0-0**
Pre-requisite: NIL **Credits**: 3

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Understand the Basic components and RF design using SDR.	PO1	3
CO2	Study the transmitter and receiver design of RF wireless system using SDR.	PO3, PO5	4
CO3	Understand VLSI design of receiver for wireless communication.	PO1	4
CO4	Understand VLSI design of transmitter for wireless communication.	PO4, PO5	4

Syllabus

Basic components and architecture of SDR, design issues of RF implementation of wireless system, re-configurability of RF hardware design using SDR. Basic issues in RF designing and Baseband processing of radio frequency design, flexibility of RF chain design using SDR.

Transmitter and receiver design of RF wireless system SDR design to implement transmitter design using modulation schemes in analog and digital domain, Receiver design including filtering, and demodulation, estimation of Bit error rate for simple structure of BPSK and QPSK.

Communication Concepts: Wireless Channel Description, Path Loss, Multipath Fading, Channel Model and Envelope Fading, Frequency Selective and Fast Fading Receiver Architectures: Receiver Front End: Filter Design, Rest of Receiver Front End, Derivation of NF, IIP3 of Receiver Front End, Low Noise Amplifier: Wideband LNA Design, Narrow Band LNA:, Impedance Matching, Core Amplifier .

Transmitter Architectures and Power Amplifier: Introduction, transmitter Back End: General

Discussion, Quadrature LO Generator, Power Amplifier Design, Analog-to-Digital Converters: Demodulators, A/D converters Used in a Receiver

Textbooks

1. Tony J Rouphael, "RF and DSP for SDR," Elsevier Newnes Press, 2008.

Dr. M. SUMA
Professor
Department of ECE
Green Fields, Vaddeswaram
Guntur Dist., A.P. Pin-522

2. Bosco Leung, "VLSI for Wireless Communication, Second Edition, Springer

References Books

1. P. Kenington, "RF and Baseband Techniques for Software Defined Radio," Artech House, 2005

2. David Tsee, Pramod Viswanath," Fundamentals of Wireless Communication", Cambridge Univ Press.

3. Emad N Farag, M.I Elmasry, "Mixed Signal VLSI Wireless Design Circuits and Systems", KluwerPublication

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

EMI/EMC & ELECTRONIC WARFARE

Course Code: 20EC51A1 **L-T-P: 3-0-0-0**
Pre-requisite: NIL **Credits: 3**

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Understand the concept of electromagnetic interference (EMI) in circuits and measurement techniques with open area test sites.	PO1, PO2	2
CO2	Demonstrate the techniques like grounding, shielding, bonding and EMI filters in the usage of cables, connectors, and components.	PO2, PO1	2
CO3	Understand the mathematical models of electronic systems as targets of electronic warfare	PO1, PO2	2
CO4	Describe the mathematical models of systems and techniques for jamming and their effectiveness.	PO1, PO2	2

Syllabus:

Introduction, Natural and Nuclear sources of EMI / EMC: Electromagnetic environment, History, Concepts, Practical experiences and concerns, frequency spectrum conservations. An overview of EMI / EMC, Natural and Nuclear sources of EMI. EMI from apparatus, circuits, and open area test sites: Electromagnetic emissions, noise from relays and switches, non-linearities in circuits, passive inter-modulation, cross talk in transmission lines, transients in power supply lines, electromagnetic interference (EMI). Radiated and conducted interference measurements and ESD. Grounding, Shielding, Bonding and EMI filters: Principles and types of grounding, shielding, and bonding, characterization of filters, power lines filter design. Cables, connectors, components, and EMC standards: EMI suppression cables, EMC connectors, EMC gaskets, Isolation Transformers, opto-isolators, National / International EMC standards. Targets of Electronic Warfare Operations: A General Description of Targets of Electronic Warfare Operations, Mathematical Models of Electronic Systems as Targets of Electronic Warfare, Mathematical Models of Automated Systems for the Control of AAD Forces as Targets of EW, Mathematical Models of Automated Systems for the Control of AAD Weapons as Targets of Electronic Warfare. Mathematical Models of Signals, Systems and Techniques for Electronic Jamming: A General Description of the Basic Elements of Electronic Jamming, Mathematical Models of Jamming Signals, Mathematical Models of Systems and Techniques for Jamming. Electronic Warfare Effectiveness Criteria: General Characteristics of the Criteria, Information Indicators of the Effectiveness of Jamming Signals, Systems and

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

Techniques of Electronic Attack, Energy Effectiveness Criteria of Jamming Signals and Techniques of Electronic Jamming.

Text Books:

1. Dr. V.P. Kodali, "Engineering Electromagnetic Compatibility", IEEE Publication, Printed in India by S. Chand & Co. Ltd., New Delhi, 2000.

2. Sergei A. Vakin,Lev N. Shustov, Robert H. Dunwell, "Fundamentals of Electronic Warfare, Artech House

Reference Books:

1. C.R. Pal, "Introduction to Electromagnetic Compatibility", A John Wiley & Sons, Inc. Publication, 1992.

2. Electromagnetic Interference and Compatibility IMPACT series, IIT – Delhi, Modules1 –9.

3. Electronic Warfare Pocket Guide (Radar, Sonar and Navigation), Adamy, David L., Publisher: Scitech Publishing, 2011.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

MACHINE LEARNING & SOFT COMPUTING APPLICATIONS IN COMMUNICATION

Course Code: 20EC52D1 **L-T-P-S: 3-0-0-0**
Pre-requisite: NIL **Credits: 3**

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Able to demonstrate various machine learning algorithms	PO4	3
CO2	Able to understand soft computing principles	PO1	3
CO3	Able to apply deep reinforcement learning principles to wireless networks	PO6	3
CO4	Able to apply deep learning for RADAR and communication processes.	PO6	3

Syllabus

Machine learning Algorithms: Linear Regression, Support Vector Machine, Linear Classifiers, Naïve Bayes Classification, Random Forest, K-Nearest Neighbor (KNN), Principal Component Analysis (PCA), K-Means Clustering. **Applications:** Image Identification, Sentiment Analysis, Speech Recognition, Classification, Time series forecasting.

Neural networks: Neuron Model and Network Architectures, Introduction to Learning processes: Error-Correction Learning, Memory-Based Learning, Hebbian Learning, Competitive Learning, Boltzmann Learning

Single layer perceptron: Adaptive Filtering, Unconstrained Optimization Techniques, Least-Mean-Square Algorithm, Perceptron Convergence;

Multilayer perceptron: Output Representation and Decision Rule, Feature Detection, Back-Propagation and Differentiation, Network Pruning Techniques, Convolutional Neural Networks.

Deep Reinforcement Learning for Wireless Networks: Introduction to Deep Learning, Deep Reinforcement Learning (DRL): Q-Learning, Multi-Armed Bandit Learning (MABL), Actor– Critic Learning (ACL), Regression, KNN and SVM Models for Wireless, Deep Learning in Wireless Network, Deep Reinforcement Learning in Wireless network, Traffic engineering and routing, Resource sharing and scheduling, Power control and data collection.

Applications of ML and Deep learning to Wireless Communications: Spectrum accessing and sharing, coverage and capacity optimization, optimal resource allocation, energy efficiency

Dr. M. SUMAN
Professor & Head
Department of ECE
KLEF
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

optimization, Adaptive modulation and coding design, joint channel equalization and signal detection.

Textbooks

1. Krishna Kant Singh, Akansha Singh, Korhan çengiz, "Machine Learning and Cognitive Computing for Mobile Communications and Wireless Networks," Wiley, 2020.
2. Simon S. Haykin "Neural Networks: A Comprehensive Foundation"Prentice Hall, 1999.
3. Fa-Long Luo, "Machine Learning for Future wireless communications," Wiley, 2020.

Reference Books

1. Martin T. Hagan, Howard B. Demuth, Mark Hudson Beale, Orlando De Jesús, "Neural Network Design," Martin Hagan, 2014.
2. Tom Mitchel, "Machine Learning," Mc.Grawhill, 2017.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 507

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Phone No. 08645 - 350200; www.klef.ac.in; www.klef.edu.in; www.kluniversity.in
Admin Off. 29-30-36, Museum Road, Governorpet, Vijayawada - 520 002. Ph: (91 - 866 - 3500122, 2577716, 2576120)

MODERN DIGITAL AND WIRELESS COMMUNICATION

Course Code: 20EC5101 **L-T-P-S: 3-1-2-0**
Pre-requisite: NIL **Credits: 3**

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Illustrate the various digital modulation techniques like ASK, PSK, QAM, etc., and select a modulation scheme based on error performance	PO1, PO2	2
CO2	Build cellular concept, frequency reuse, and handoff strategies.	PO4, PO3	3
CO3	compare the designed wireless and cellular communication systems over a stochastic fading channel	PO4, PO5	3
CO4	classify Equalizers and diversity techniques in mobile receiver design	PO5	4
CO5	Analyze various digital communication and wireless communication system their applications	PO7	4

Syllabus:

Digital communication systems: Elements of a Digital Communication System, mathematical models for communication channels, Communication channels and their characteristics. Representation of bandpass signals and system, Signal space representations. Representation of digitally modulated signals, Memoryless modulation methods-Pulse Amplitude Modulation, Phase Modulation schemes, Quadrature Amplitude Modulation. Introduction to Wireless Communications: Examples of Wireless Communication Systems, Cellular telephone Systems, 2G & 3G wireless networks, Cellular concept, frequency reuse, Channel Assignment strategies, Hand off strategies, Interference and system capacity, improving coverage and capacity in cellular systems. Mobile Radio Propagation: Large Scale Fading, Free space propagation model, Three basic propagation mechanisms: Reflection, diffraction, scattering, Small Scale Fading, Multipath Propagation, Types of small scale fading, Parameters of Mobile Multipath channels, fading effects due to multipath delay Spread and Doppler spread, Rayleigh and Ricean distribution models. Statistical models for multipath fading channels. Equalization and Diversity Techniques: Equalization, Fundamentals of Equalizers, Linear equalizers, nonlinear equalizers, Decision feedback equalizers, MLSE, Algorithms for adaptive equalization, Space diversity, MRC, EGC,

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

selection diversity, Polarization diversity, Frequency diversity, Time diversity, Rake receiver. Multiple Access Techniques – TDMA, FDMA, CDMA

Text Books:

1. J.G. PROAKIS, ' Digital communications', MGH, 4th edition, 2001.

2. Theodore S. Rappaport, Wireless Communications: Principles & Practice, Prentice Hall, 2002.ISBN 0-13-042232-0

Reference Books:

1. Simon Haykin, Digital communications, John Wiley and sons, 1998 2. Wayne Tomasi.

2. Advanced electronic communication systems, 4th Edition Pearson Education Asia, 1998.

3. B.P.Lathi Modern digital and analog communication systems, 3rd Edition, Oxford University press

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

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MODERN RADAR SYSTEMS AND AUTONOMOUS VEHICLES

Course Code: 20EC5207 **L-T-P-S:3-0-2-0**
Pre-requisite: NIL **Credits: 4**

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Summarize the advanced techniques in modern radar system and categorize advanced pulse compression waveform modulations and techniques.	PO1, PO6	2
CO2	Understand the concept of MIMO radar system and applications.	PO2	3
CO3	Understand adaptive digital beam-forming principles	PO3	3
CO4	Understand the concepts of Automotive radar through Intelligent Transportation System Applications	PO4, PO6	4

Syllabus

Advanced Techniques in Modern Radar: Introduction, Radar Modes, Radar and System Topologies. Advanced Pulse Compression Waveform Modulations and Techniques: Introduction, Stretch Processing, Stepped Chirp Waveforms, Nonlinear Frequency Modulated Waveforms, Stepped Frequency Waveforms, Quadriphase Signals, Mismatched Filters.

MIMO Radar: Introduction, An Overview of MIMO Radar, The MIMO Virtual Array, MIMO Radar Signal Processing, Waveforms for MIMO Radar, Applications of MIMO Radar.

Adaptive Digital Beamforming: Introduction, Digital Beamforming Fundamentals, Adaptive Jammer Cancellation, Adaptive Beamformer Architectures, Wideband Cancellation.

Intelligent Transportation System Applications: Automotive Radar, Long-Range Radar, Medium-Range Radar Short-Range Radar Adaptive Cruise Control System, Road Departure Warning System, Blind Spot Monitoring and Lane Change Control System, Obstacle Detection, Radar-Based Communications, Radar-Based Automatic Road Transportation System, Driving.

Textbooks

1. William L.Melvin, James A. Scheer, "Principles of Modern Radar", Volume II: Advanced Techniques, SciTech Publishing, 2008.

2. Shao-Qiu Xiao, Ming-Tuo Zhou, Yan Zhang, "Millimeter Wave Technology in Wireless PAN, LAN, and MAN", Auerbach Publications CRC Press.

Reference Books

1. Richards, M.A., Scheer, J.A., and Holm, W.A. (Eds.), *Principles of Modern Radar: Basic Principles,* SciTech Publishing, Raleigh, NC, 2010.
2. R.A. Monzingo and T.W. Miller. *Introduction to Adaptive Arrays*. SciTech, Raleigh, NC, 2011.
3. Johnson, D.H. and Dudgeon, D.E., *Array Signal Processing: Concepts and Techniques*, Prentice Hall, Englewood Cliffs, NJ, 1993.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

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Phone No. 08645 - 350200 www.klef.ac.in; www.klef.edu.in; www.kluniversity.in
Admin Off: 20-36-38, Museum Road, Governorpet, Vijayawada - 520 002 Ph: +91 - 866 - 3500122, 2577715, 2576129

NEXT GENERATION NETWORKING AND COMMUNICATION TECHNOLOGIES

Course Code: 20EC51B3 **L-T-P-S: 3-0-0-0**
Pre-requisite: NIL **Credits: 3**

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Interpreting wireless WAN, PAN and LAN concepts, equipment, standards, and specifications	PO4	2
CO2	Understand the wireless networks and its technologies	PO1, PO6	3
CO3	Understand the data transfer via GPRS and protocols	PO4	3
CO4	Understand the 4G systems and technologies	PO1, PO3	4

Syllabus

Wireless PAN and LAN: Introduction to Bluetooth, Protocol Stack, Network Connection Establishment, Network topology, Bluetooth applications, Zigbee technology. Introduction to Wireless LANs, WLAN Equipment, Topologies, and Technologies. IEEE802.11: Architecture and Services, Physical Layer, Data Link Layer, MAC sub layer, IEEE 802.16 WiMAX: Roadmap, physical layer, MAC layer and spectrum allocation.

Wireless Wide Area Networks: UMTS – Network architecture, CODEC, bearer service and QoS. CDMA: CDMA 2000 layering structure, forward link features, reverse link physical channels, WCDMA, evolution of IS 95 to CDMA 2000, IMT 2000, HSPA, HSPA+, LTE and LTE advanced.

Overview of Wireless n/w. and Technologies: Introduction, Different generations. Introduction to 1G, 2G, 3G and 4G, Bluetooth, Radio frequency identification (RFID), Wireless Broadband, Mobile IP: Introduction, Advertisement, Registration, TCP connections, two level addressing, abstract mobility management model, performance issue, routing in mobile host, Adhoc networks, Mobile transport layer: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission, transaction-oriented TCP. IPv6 Wireless network topologies, Cell fundamentals and topologies, Global system for mobile communication, GSM architecture, GSM entities, call routing in GSM, PLMN interface, GSM addresses and identifiers, network aspects in GSM, GSM frequency allocation, authentication and security, Short message services, Mobile computing over SMS, value added services through SMS, accessing the SMS bearer, Security in wireless networks.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram.
Guntur Dist., A.P. PIN: 522 502

General packet radio service (GPRS): GPRS and packet data network, GPRS network architecture, GPRS network operation, data services in GPRS, Applications of GPRS, Billing and charging in GPRS.

Wireless Application Protocol (WAP), MMS, GPRS application CDMA and 3G: Spread-spectrum Technology, FHSS, DSSS, CDMA versus GSM, Wireless data, third generation networks, applications in 3G Wireless LAN, WIFI v/s 3G Voice over Internet protocol and convergence, Voice over IP,H.323 framework 13 20 for voice over IP, SIP, comparison between H.323 and SIP.

Fourth Generation Systems and Technologies: 4G vision, features and challenges, applications, 4G technologies: Multicarrier modulation, smart antenna techniques, OFDM – MIMO systems, Adaptive modulation and coding with time slot scheduler, BLAST system, SDR and cognitive radio.

Introduction and Roadmap to 5G: Historical trend and evolution of LTE technology to beyond 4G, Key building blocks of 5G, 5G use cases and System Concepts, The 5G Architecture, IoT: relation to 5G.

RF Front end for 5G: Millimeter Wave Communications: Hardware technologies for mm wave systems, Architecture and Mobility, Massive MIMO: Resource allocation and transceiver algorithms for massive MIMO, Fundamentals of baseband and RF implementations in massive MIMO, Beamforming.

TEXTBOOKS

1. Vijay K Garg, "Wireless Communication and Networking", Morgan Kaufmann Publishers, 2010.

2. Jonathan Rodriguez, - Fundamentals of 5G mobile networks, John Wiley & Sons, Ltd, 2015.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

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Admin Off: 29-36-38, Museum Road, Governorpet, Vijayawada - 520 002. Ph: +91 - 866 - 3500122, 2577715, 2576129

OPTICAL NETWORKS & SATELLITE COMMUNICATIONS

Course Code: 20EC5208 **L-T-P: 3-0-0-0**
Pre-requisite: NIL **Credits: 3**

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Understand and recognize various Satellite Systems, architecture, and Sub-modules	PO5	2
CO2	Interpret and demonstrate Satellite Link Design for LEO, MEO, HEO and GEO with respective ground and for High altitude platforms.	PO4	2
CO3	Describe and identify the basic network components required for setting up an optical network gateway.	PO3	2
CO4	Understanding the process of Wavelength Assignment and ability to reconfigure/re-modify the optical network as per the demand	PO4	2

Syllabus:

Introduction to Satellite Systems, architecture, and Sub-modules Satellite system Architecture/sub-Modules Overview: Satellite Bus Structure, Actuators – Reaction Wheel & Magnetic Torquer, Sensors – Gyro, Sun Sensor, Star Sensor, Magneto Meter & GPS/SPS, Thermal Control System – Temperature Sensor, Heaters & Multi-Layer Insulation (MLI); Optical Solar Reflectors (OSR) Sheets, Antenna system (VHF, UHF, S, X, C, K, Ku, Ka and MM band), Communication system – TTC transceiver and Payload Downlink, Payload system – Optical & RF payloads, On-Board Computer – Processor & ADCS Control, Power System - Electrical Power System, Battery and Power Distribution System, Solar Panel.

Mission planning and Link Design Basic transmission theory - FSL, antenna theory, gain, radiation patter, EIRP, satellite look angles and ranges. Noise sources, noise temp, noise figure, sky noise G/T ratio and calculation C/N for up-path and down-path. Intermodulation, back-off, interference and C/I calculation. Effects of rain for FSS and multipath shadowing for MSS systems - calculation of margins. Link budget with overall C/N and availability. Meaning of QoS. Differences between GEO and non-GEO link budgets.

Optical networks Overview of Layered Architectural Model, Interfaces to the Optical Layer, Optical Control Plane, Terminology, Network Design and Network Planning, Research Trends in Optical Networking, Focus on Practical Optical Networks, Optical Network Elements Basic Optical

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502.

Components, Optical Terminal, Optical-Electrical-Optical (O-E-O) Architecture, Optical Bypass, OADMs/ROADMs, Multi-degree ROADMs, ROADM Architectures, ROADM Properties, Optical Switch Types, Hierarchical or Multigranular Switches, Optical Reach, Integrating WDM Transceivers in the Client Layer, Packet-Optical Transport, Photonic Integrated Circuits and Multi-Fiber-Pair Systems.

Wavelength Assignment Role of Regeneration in Wavelength Assignment, Multistep RWA, One-Step RWA, Wavelength Assignment Strategies, Subconnection Ordering, Bidirectional Wavelength Assignment, Wavelengths of Different Optical Reach, Nonlinear Impairments Due to Adjacent Wavelengths, Alien Wavelengths, Wavelength Contention and Network Efficiency Flexible Optical Networks Fiber Capacity Limits, Flexible-Grid Architectures, Gridless Architectures and Elastic Networks, Routing and Spectrum Assignment, Spectral Defragmentation, Technologies for Flexible-Grid and Grid less Networks, Flexible-Grid Versus Grid less Architectures and Programmable (or Adaptable) Transponders

Text Books:

1. Timothy Pratt, Jeremy E. Allnutt (2019) Satellite Communications, 3rd Edition, ISBN: 978-1-119-48217-8, Publisher: Wiley.

2. Gerard Maral, Michel Bousquet, Zhili Sun (2011) Satellite Communications Systems: Systems, Techniques and Technology, 5th Edition, ISBN: 978-1-119-96509-1, Publisher: Wiley.

3. Takashi Iida (2000) Satellite Communications: System and Its Design Technology, ISBN-10: 9781586030858, ISBN-13: 978-1586030858 Publisher: Ohmsha.

4. Bruce Elbert (2008) Introduction to Satellite Communication, ISBN: 9781596932104, Publisher: Artech House.

5. Jane M. Simmons (2014) Optical Network Design and Planning, DOI: 10.1007/978-3-319-05227-4, Hardcover ISBN: 978-3-319-05226-7, Softcover ISBN: 978-3-319-33097-6, Publisher: Springer International Publishing

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

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4G, 5G, AND MODERN WIRELESS TECHNOLOGIES

Course Code: 20EC5205 **L-T-P: 3-1-2-0**
Pre-requisite: NIL **Credits: 5**

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Spreading Sequences and Multi user systems: Properties of spreading sequences, PN sequences, Gold Sequences and Walsh Sequences. Orthogonal variable spreading factor sequences (OVSF). Introduction to CDMA, DSCDMA, Multiuser detection, DSSS Techniques, FHSS verses DSSS	PO1, PO2	2
CO2	Multi carrier Communication Systems: Introduction to multiuser modulations, Principal of OFDM(Block Diagram), Cyclic Prefix, Introduction to long term evaluation(LTE-5E), Transceivers, Channel estimation, OFDM issues, Peak to Average Power ratio (PAPR), Carrier frequency Offset (CFO), Synchronization, PAPR reduction techniques, Multicarrier and Multi-access Systems- OFDMA, MCCDMA.	PO1	3
CO3	MIMO systems – spatial multiplexing. Ultra Wideband Communications: Channel Models, VBAST Architecture, Channel Modeling, SIMO, MISO, MIMO fading channels-MIMO diversity-Almouty, Orthogonal space time block code, OSTBC- MIMO-SSC, MIMO-OFDM, Introduction to features of UWB technology- applications, UWB indoor channel, UWB Capacity, Pulsed UWB, Pulse shape, Modulation and Multiple access of Pulse UWB, Time Hopping, DSUWB	PO3	3
CO4	Advanced cellular communications and Miscellaneous topics: Study of 60 Hz cellular systems, Cellular fixed stations, Cellular systems in rural service areas, Diversity media systems with millimeter wave and Optical wave link and Cellular radio telecommunications systems, Cell Handoff, Cellular switching-Analog and Digital, Call Routing-Special features of handling traffic. Challenges for Pulsed UWB systems- Multiband UWB-Modulation of Pulsed Multiband UWB, Multiband OFDM UWB, Introduction to 5	PO1	3

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

CO5	4G and 5G Modern wireless Technologies	PO1	3

Syllabus

Spreading Sequences and Multi user systems: Properties of spreading sequences, PN sequences, Gold Sequences and Walsh Sequences. Orthogonal variable spreading factor sequences (OVSF). Introduction to CDMA, DSCDMA, Multiuser detection, DSSS Techniques, FHSS verses DSSS. Multi carrier Communication Systems: Introduction to multiuser modulations, Principal of OFDM(Block Diagram), Cyclic Prefix, Introduction to long term evaluation(LTE-5E), Transceivers, Channel estimation, OFDM issues, Peak to Average Power ratio (PAPR), Carrier frequency Offset (CFO), Synchronization, PAPR reduction techniques, Multicarrier and Multi-access Systems-OFDMA, MCCDMA. MIMO systems – spatial multiplexing. Ultra-Wideband Communications: Channel Models, VBAST Architecture, Channel Modeling, SIMO, MISO, MIMO fading channels-MIMO diversity-Almouty, Orthogonal space time block code, OSTBC- MIMO-SSC, MIMO-OFDM, Introduction to features of UWB technology- applications, UWB indoor channel, UWB Capacity, Pulsed UWB, Pulse shape, Modulation and Multiple access of Pulse UWB, Time Hopping, DSUWB. Advanced cellular communications and Miscellaneous topics: Study of 60 Hz cellular systems, Cellular fixed stations, Cellular systems in rural service areas, Diversity media systems with millimeter wave and Optical wave link and Cellular radio telecommunications systems, Cell Handoff, Cellular switching- Analog and Digital, Call routing-Special features of handling traffic. Challenges for Pulsed UWB systems- Multiband UWB- Modulation of Pulsed Multiband UWB, Multiband OFDM UWB, Introduction to 5

Text Books :1 KE-Lin DU and M.N.Swamy, Wireless Communication Systems. 2 David TSE and PromodViswanadhan, Fundamentals of Wireless communication 3 William C.Y.Lee Mobile cellular Telecommunications TMH Publications 2006

Reference Books: SAVOGlisic, Advanced Wireless communications 4G Technologies.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

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Admin Off: 29-36-38, Museum Road, Governorpet, Vijayawada - 520 002. Ph: +91 - 866 - 3500122, 2577715, 2576129.

RADAR ENGINEERING & MM RADAR

Course Code: 20EC5103 **L-T-P: 3-0-0-0**
Pre-requisite: NIL **Credits: 3**

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Understand the Radar operation principle and know the Basic quantities of Radar measurements.	PO1	2
CO2	Understand the Radar design principle and illustrate about the subsystems and components of Radar system.	PO4	2
CO3	Understand the Propagation and Scattering mechanisms of Millimeter-Length Waves	PO1	2
CO4	Describe various Remote Sensing applications and advantages of Radar system in Civil, Environment, Military and Navigational applications	PO2	2

Syllabus:

The Radar and its Ground Environment: Primary and Secondary Radar, Coordinate systems and range, Main monostatic radar components, Basic quantities, maximum range, Secondary radar, Bistatic radar, Performance. Radar Design Principles: Radar Tasks, Physical Processes, Sounding Waveforms, Radar Signals and Information , Spatial Resolution, Pulse Compression and Synthetic Aperture, Target Selection, Radar Detection, Radar Measurement Nonclassical Types of Radar: Radar Subsystems and Components, Transmitters, Antennas, Receivers, Integrated Circuits Technology, Other Components Propagation and Scattering of Millimeter-Length Waves: Molecular Absorption, Attenuation in Hydrometeors, Integrated Influence of Gaseous and Hydrometeor, Attenuation, Refraction, Underlying Terrain Irregularities, Turbulence, Scattering and RCS. Remote Sensing Applications: Cloud Radar, Features, Methods, and Advantages, Examples of Systems and Applications, Remote Sensing of the Terrain, Imaging Systems for Security and Safety Applications, Miniature Radar and Radiometric Systems for CWD, Applications, Safety Navigation Applications including FOD of Airfield.

Text Books:

1. Shao-Qiu Xiao, Ming-Tuo Zhou, Yan Zhang , "Millimeter Wave Technology in Wireless PAN, LAN, and MAN", Auerbach Publications CRC Press.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 50

2. Hamish Meikle, "Modern Radar Systems", Second Edition, Artech House Radar Library.

Reference Books:

1. N. C. Currie and C. E. Brown, Principles and Applications of Millimeter Wave Radar, Artech House, Inc., Norwood, MA, 1987.

2. E. K. Reedy and J. C. Wiltse, "Fundamentals of millimeter-wave (MMW) radar systems," in Aspects of Modern Radar, by E Brookner, Ed., Artech House, Norwood, MA, 1998.

3. G. P. Kulemin, Millimeter-Wave Radar Targets and Clutter, Artech House, Norwood, MA, 2003.

Dr. M. SUMAN
Professor & Head
Department of ECE
KLEF
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

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Phone No. 08645 - 350200, www.klef.ac.in; www.klef.edu.in; www.kluniversity.in
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RF SYSTEM AND ANTENNA DESIGN

Course Code: 20EC5104 **L-T-P: 3-1-0-0**
Pre-requisite: NIL **Credits: 4**

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Classifying the design consideration of RF/MW circuits, signal flow in a circuit, interpretation of measurements in-terms of Scattering and Impedance, HF and MW filter design process.	PO1, PO2	2
CO2	Interpreting the amplifier/oscillator design process and identifying the stability, gain and noise figure with respective BJT and FET module.	PO3, PO2	2
CO3	Interpreting aperture antenna design principles with mathematical analysis.	PO2, PO3	2
CO4	Interpreting array antenna design principles with mathematical analysis.	PO4, PO5	2

Syllabus:

Design considerations of RF Filters: RF Filter Design: Scattering Parameters: Definition, Meaning, Chain Scattering Matrix, Conversion Between S- and Z-parameters, Signal Flow Chart Modelling, Generalization-Basic Resonator and Filter Configurations: Low Pass, High Pass, Band Pass and Band Stop type Filters-Filter Implementation using Unit Element and Kuroda's Identities Transformations.

Design Considerations of RF Amplifiers and Oscillators: Characteristics of amplifier-amplifier power relations-stability consideration-constant gain-broadband, high power, and multistage amplifiers, Small signal analysis of amplifiers. Basic oscillator model-high frequency oscillator configuration.

Aperture Antennas: Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Fourier transform method in aperture antenna theory, Horn and Reflector Antennas: Radiation from sectoral and pyramidal horns, design concepts, prime-focus parabolic reflector and cassegrain antennas. Microstrip Antennas: Basic characteristics, feeding methods, methods of analysis, design of rectangular and circular patch antennas.

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram.
Guntur Dist., A.P. PIN: 522502

Antenna Arrays: Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays, synthesis of antenna arrays using Schelkunoff polynomial method, Fourier transform method, and Woodward-Lawson method.

Text Books:

1. Balanis, C.A., "Antenna Theory and Design", 3rd Ed., John Wiley & Sons (2005).

2. Jordan, E.C. and Balmain, K.G., "Electromagnetic Waves and Radiating Systems", 2nd Ed., Prentice-Hall of India (1993).

3. Stutzman, W.L. and Thiele, H.A., "Antenna Theory and Design", 2nd Ed., John Wiley & Sons (1998).

4. Garg, R., Bhartia, P., Bahl, I. and Ittipiboon, A., "Microstrip Antenna Design Handbook", Artech House (2001).

5. Mathew M. Radmanesh, "Radio Frequency & Microwave Electronics", Pearson Education Asia, Second Edition.

6. Reinhold Ludwig and Powel Bretchko, "RF Circuit Design – Theory and Applications", Pearson Education Asia, First Edition.

Reference Books:

1. Joseph . J. Carr, "Secrets of RF Circuit Design", McGraw Hill Publishers, Third Edition.

2. Ulrich L. Rohde and David P. New Kirk, "RF / Microwave Circuit Design", John Wiley & Sons.

Dr. M. SUMAN
Professor & Head
Department of ECE
K.L.E.F.
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502

TECHNICAL SKILLING-I (MATLAB*, AWR*)

Course Code: 20TS5203 **L-T-P: 0-0-0-8**
Pre-requisite: NIL **Credits: 2**

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Basics of programming languages and syntax, as well as automation using scripting basic functions and keywords of the language, along with some arithmetic operations. Either using Matlab for Data Science projects	PO1	3
CO2	Different data types, Convert between them variables to assign data and to reference variables. Functions: how to define them, pass them parameters, and have them return information. concepts of code reuse, code style, and refactoring complex code, along with effectively using code comments. Use Case: Modelling ITU-R P.618	PO2	3
CO3	Comparing data using equality and logical operators and leveraging these to build complex branching scripts using if statements. Intricacies of loops in Python. How to use while loops to continuously execute code, as well as how to identify infinite loop errors and how to fix them. To use for loops to iterate over data, and how to use the range () function with for loops. common errors when using for loops and how to fix them. Use Case: Write code to ITU-R Models (Either Matlab & Python)	PO3	3
CO4	Manipulate HDF files, strings using indexing, slicing, and advanced formatting. Explore the more advanced data types: lists, tuples, and dictionaries. learn to store, reference, and manipulate data in these structures, as well as combine them to store complex data structures. Use Case: HDF files obtained from MOSDAC (Satellite Data)	PO4	3

Syllabus:

Basics of programming languages and syntax, as well as automation using scripting basic functions and keywords of the language, along with some arithmetic operations. Either using Matlab or Python for Data Science projects

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN- 522 5

Different data types, Convert between them variables to assign data and to reference variables. Functions: how to define them, pass them parameters, and have them return information. concepts of code reuse, code style, and refactoring complex code, along with effectively using code comments. Use Case: Modelling ITU-R P.618

Comparing data using equality and logical operators, and leveraging these to build complex branching scripts using if statements. Intricacies of loops in Python. How to use while loops to continuously execute code, as well as how to identify infinite loop errors and how to fix them. To use for loops to iterate over data, and how to use the range() function with for loops. common errors when using for loops and how to fix them. Use Case: Write code to ITU-R Models (Either Matlab & Python).

Manipulate HDF files, strings using indexing, slicing, and advanced formatting. Explore the more advanced data types: lists, tuples, and dictionaries. learn to store, reference, and manipulate data in these structures, as well as combine them to store complex data structures. Use Case: HDF files obtained from MOSDAC (Satellite Data)

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

TECHNICAL SKILLING-II (MATLAB*, AWR*)

Course Code: 20TS5204 **L-T-P: 0-0-0-8**
Pre-requisite: NIL **Credits: 2**

COURSE OUTCOMES (COs):

CO NO	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Basics of programming languages and syntax, as well as automation using scripting basic functions and keywords of the language, along with some arithmetic operations. Either using Matlab or Python for Data Science projects	PO1	3
CO2	Different data types, convert between them variables to assign data and to reference variables. Functions: how to define them, pass them parameters, and have them return information. concepts of code reuse, code style, and refactoring complex code, along with effectively using code comments. Use Case: Modelling ITU-R P.618	PO2	3
CO3	Comparing data using equality and logical operators and leveraging these to build complex branching scripts using if statements. Intricacies of loops in Python. How to use while loops to continuously execute code, as well as how to identify infinite loop errors and how to fix them. To use for loops to iterate over data, and how to use the range () function with for loops. common errors when using for loops and how to fix them. Use Case: Write code to ITU-R Models (Either Matlab & Python)	PO3	3
CO4	Manipulate HDF files, strings using indexing, slicing, and advanced formatting. Explore the more advanced data types: lists, tuples, and dictionaries. learn to store, reference, and manipulate data in these structures, as well as combine them to store complex data structures. Use Case: HDF files obtained from MOSDAC (Satellite Data)	PO4	3

Syllabus:

Basics of programming languages and syntax, as well as automation using scripting basic functions and keywords of the language, along with some arithmetic operations. Either using Matlab or Python for Data Science projects

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram.
Guntur Dist., A.P. PIN: 522 50

Different data types, convert between them variables to assign data and to reference variables. Functions: how to define them, pass them parameters, and have them return information. concepts of code reuse, code style, and refactoring complex code, along with effectively using code comments. Use Case: Modelling ITU-R P.618

Comparing data using equality and logical operators and leveraging these to build complex branching scripts using if statements. Intricacies of loops in Python. How to use while loops to continuously execute code, as well as how to identify infinite loop errors and how to fix them. To use for loops to iterate over data, and how to use the range () function with for loops. common errors when using for loops and how to fix them. Use Case: Write code to ITU-R Models (Either Matlab & Python).

Manipulate HDF files, strings using indexing, slicing, and advanced formatting. Explore the more advanced data types: lists, tuples, and dictionaries. learn to store, reference, and manipulate data in these structures, as well as combine them to store complex data structures. Use Case: HDF files obtained from MOSDAC (Satellite Data)

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswar
Guntur Dist., A.P. PIN: 522

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Annexure VII

S.No	Specialization	Course Name	Level	Year and Sem	Category
1	VLSI	Tessolve - VLSI Design & Verification	1		Employability
2	VLSI	Tessolve - Embedded System Applications & IoT	1		Employability
3	IoT and Data Computing	CDAC - IoT Technologies	1 / 2		Employability
4	Data Communication	Huawei - Data Comm Associate (Routing & Switching)	1	3.2 (Y18) & 4.2 (Y17)	Employability
5	IoT	Microsoft Azure - IoT Developer	1 / 2		Employability
6	Data Computing	Huawei - Cloud Computing - Associate	1		Employability
7	NA	AGI-STK Level 1	1		Employability
8	NA	Amateur Station Operator's Certificate Examination	1 / 2		Employability
9	Data Computing	Microsoft Certified: Azure AI Engineer Associate	1/2		Employability / Career Advancement / Entrepreneurship
10	Data Computing	Microsoft Certified: Data Analyst Associate	0/1/2		Employability / Career Advancement / Entrepreneurship
11	Data Computing	Microsoft Certified: Azure Data Engineer Associate	1/2		Employability / Career Advancement
12	Data Computing	Microsoft Certified: Azure Data Scientist Associate	1/2		Employability / Career Advancement

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

13	Data Computing	PCCET: Palo Alto Networks Certified Cybersecurity Entry-level Technician	0		Employability
14	Data Computing	Google: Associate Cloud Engineer	1		Employability
15	Data Computing	PCNSA: Palo Alto Networks Certified Network Security Administrator	1		Employability / Career Advancement
16	Data Computing	Certified Blockchain Developer Exam - Ethereum CBDE	0		Career Advancement
17	Data Computing	Microsoft Certified: Azure-Fundamentals	0		Employability
18	Data Computing	Tableau Certified Data Analyst	0		Employability / Career Advancement
19	Data Computing	SAS Certified Specialist: Text Analytics, Time Series, Exp & Optimization	0/1/2		Employability / Career Advancement / Entrepreneurship
20	Data Computing	Google TensorFlow Developer Certificate	2		Employability / Career Advancement / Entrepreneurship
21	Data Computing	MongoDB Certified Developer	0/1		Employability / Career Advancement / Entrepreneurship
22	Data Computing	PCPP – Certified Professional in Python Programming Certifications	0/1/2		Employability / Career Advancement / Entrepreneurship
23	NA	Service Now	0		Employability

Dr. M. SUMAN
Professor & Head
Department of ECE
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24	VLSI	PEGA Certified System Architect	1/2		Career Advancement / Entrepreneurship
25	VLSI	PEGA Certified Senior System Architect	2		Career Advancement
26	Data Computing	Wipro Talent Next	0		Employability
27	RF and Microwave	EPAM	1		Employability / Career Advancement
28	VLSI	Tessolve – UVM	0/1/2		Employability / Career Advancement / Entrepreneurship
29	VLSI	Tessolve - Embedded System Applications & IoT Level 2	2		Employability / Career Advancement
30	Data Computing	Huawei Certified ICT Associate Artificial Intelligence (HCIA-AI)	1		Employability
31	Data Communication	AWS Certified Cloud Practitioner	0/1/2		Employability / Career Advancement / Entrepreneurship
32	VLSI	Red Hat Certified Enterprise Application Developer	1		Employability
33	NA	Microsoft Certified: Azure AI Fundamentals	0		Employability
34	NA	ServiceNow Certified System Administrator	1		Employability
35	NA	Microsoft Certified: Power BI Data Analyst Associate	1		Employability / Career Advancement

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram
Guntur Dist., A.P. PIN: 522 502

36	NA	Exam DP-900: Microsoft Azure Data Fundamentals	0		Employability
37	NA	NI CLAD	0/1/2		Employability / Career Advancement / Entrepreneurship

Dr. M. SUMAN
Professor & Head
Department of ECE
K L E F
Green Fields, Vaddeswaram,
Guntur Dist., A.P. PIN: 522 502