SDG's mapping for "Image processing for Engineering applications" course

1.Units mapping with SDG's

Unit	Topic	Relevant SDG(s)	Justification
Unit I	Image Processing with MATLAB: Digital images, color spaces, thresholding, contrast enhancement	SDG 4 – Quality Education SDG 9 – Industry, Innovation & Infrastructure	Introduces foundational skills in digital image manipulation and MATLAB, essential for engineering education and innovation.
Unit II	Feature Extraction: Edges, Hough Transform, Gabor filters, texture descriptors	SDG 3 – Good Health and Well-being SDG 15 – Life on Land	Feature extraction methods are widely used in medical imaging (e.g., tumor detection) and environmental monitoring (e.g., deforestation tracking).
Unit III	Registration and Image Fusion: Transformations, Resampling, Fusion techniques	SDG 11 – Sustainable Cities and Communities SDG 13 – Climate Action	Supports urban change detection, disaster response mapping, and remote sensing for climate analysis by aligning and integrating multi-source images.
Unit IV	3D Image Visualization: Volumetric display, Ray tracing, Measurements on 3D images	SDG 3 – Good Health and Well-being SDG 14 – Life Below Water	Used in 3D medical diagnostics (CT/MRI) and marine biology for visualizing underwater environments and species behavior.

2.Course Outcome (CO) mapping with SDG's

Course Outcome (CO)	Mapped SDG(s)	Justification
CO1: Illustrate the fundamentals of image processing using MATLAB	SDG 4 – Quality Education SDG 9 – Industry, Innovation and Infrastructure	Builds foundational digital skills for modern engineering education and prepares students for innovation in imaging applications.
CO2: Summarize various Feature Extraction techniques	SDG 3 – Good Health and Well-being SDG 15 – Life on Land	Used in medical imaging (tumor/organ analysis) and environmental monitoring (deforestation, wildlife detection).

CO3: Assess spatial filters for image processing applications	SDG 7 – Affordable and Clean Energy SDG 12 – Responsible Consumption and Production	Spatial filtering aids in quality control and sustainable production, e.g., inspecting solar panels or reducing image noise in energy systems.
CO4: Illustrate the concepts of image registration	SDG 11 – Sustainable Cities and Communities SDG 13 – Climate Action	Image registration aligns multi-source images for urban planning, land use analysis, and disaster response.
CO5: Illustrate the concepts of image fusion	SDG 13 – Climate Action SDG 3 – Good Health and Well-being	Fusion of sensor data helps in both climate change tracking (e.g., flood/wildfire detection) and combining medical images for diagnostics.
CO6: Outline 3D image visualization	SDG 3 – Good Health and Well-being SDG 14 – Life Below Water	Supports 3D visualization of organs (MRI/CT) and analysis of marine life and underwater environments for research and health purposes.

SDG	Goal Title	Justification Highlight	Relevant Topics/Units
SDG 3	Good Health and Well-being	Image processing is used in medical diagnostics, such as detecting tumors, analyzing MRI/CT scans, and monitoring neurological/cardiological signals.	Feature Extraction (Unit II), 3D Image Visualization (Unit IV), Image Fusion (Unit III)
SDG 4	Quality Education	Enhances technical education and analytical skills in engineering through hands-on MATLAB practice, foundational for digital imaging careers.	MATLAB Basics, Image Display and Contrast (Unit I)
SDG 9	Industry, Innovation and Infrastructure	Equips students to work on industrial inspection, automation, and machine vision systems using image analysis techniques.	Edge Detection, Gabor/Wavelet Filters (Unit II), Spatial Filters and Thresholding (Unit I)
SDG 11	Sustainable Cities and Communities	Supports urban development monitoring, infrastructure change detection, and disaster assessment through image registration and fusion.	Image Registration and Fusion (Unit III)

SDG 13	Climate Action	Enables environmental image analysis (e.g., flood mapping, vegetation monitoring) by fusing and analyzing satellite images.	Transformation, Resampling, Wavelet Fusion (Unit III)
SDG 14	Life Below Water	Used in marine research for analyzing underwater images, tracking aquatic life, and mapping coral reef health using 3D visualization.	3D Visualization Techniques (Unit IV)
SDG 15	Life on Land	Supports wildlife monitoring, deforestation detection, and land use change analysis through texture and shape-based feature extraction.	Texture Descriptors, Boundary/Moment Features (Unit II)

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Image Processing Mapping to Sustainable Development Goals (SDGs)

B.Tech (ECE) – 6th Semester

Course Title : **Image Processing**

Course Code : 21ECC32 Academic Year: 2024-2025

Course Structure: 3-0-2-4

Course Coordinator : Dr.N.Chandrasekhar

Instructors : Dr.N.Chandrsekhar

Unit	Topic(s)	Mapped SDG(s)	Justification
I	Digital Image Fundamentals, Color Models, Image Conversion	**SDG 4** – Quality Education **SDG 9** – Industry, Innovation & Infrastructure	Enhances students' foundational knowledge in image processing, promoting innovation and digital skills essential for modern industries and research.
II	Image Enhancement – spatial & frequency domain	**SDG 3** – Good Health & Well-Being **SDG 9** – Industry, Innovation & Infrastructure	Image enhancement techniques are widely used in medical imaging (X-ray, MRI) for improved diagnosis, contributing to health and technological advancement.
III	Image Restoration – noise removal, inverse filtering	**SDG 3** – Good Health & Well-Being **SDG 11** – Sustainable Cities & Communities	Restoration improves clarity in satellite and surveillance images for disaster response and urban planning, impacting safety and sustainable city development.
IV	Image Segmentation & Compression – thresholding, Huffman, transform coding	**SDG 9** – Industry, Innovation & Infrastructure **SDG 12** – Responsible Consumption & Production	Compression enables efficient storage and transmission of image data, supporting sustainable resource use and innovation in digital communication and AI systems.

Course Outcome (CO)	Mapped SDG(s)
CO1: Demonstrate the Basic image Operations and fundamental concepts.	**SDG 4** – Quality Education **SDG 9** – Industry, Innovation & Infrastructure
CO2: Execute various conversion operations on digital images.	**SDG 9** – Industry, Innovation & Infrastructure
CO3: Implement image enhancement techniques in spatial and frequency domain.	**SDG 3** – Good Health & Well-Being **SDG 9** – Industry, Innovation & Infrastructure
CO4: Implement various filters for image restoration.	**SDG 3** – Good Health & Well-Being **SDG 11** – Sustainable Cities & Communities
CO5: Execute segmentation techniques for digital images.	**SDG 11** – Sustainable Cities & Communities **SDG 3** – Good Health & Well-Being
CO6: Implementation of image lossless and lossy compression techniques.	**SDG 12** – Responsible Consumption & Production **SDG 9** – Industry, Innovation & Infrastructure

Justification Highlights

SDG 3 – Good Health and Well-Being

Mapped Topics / COs	Justification Highlight
Unit II: Image Enhancement	Used in medical imaging (e.g., MRI, X-ray) to enhance image clarity for accurate diagnosis.
Unit III: Image Restoration	Removes noise from medical and biomedical images to assist in better clinical interpretation.
CO3: Implement enhancement techniques	Critical for improving image quality in health diagnostics.
CO4: Apply filters for image restoration	Enhances readability of medical and pathological scans.
CO5: Apply segmentation techniques	Enables precise organ or tumor identification in medical imaging systems.

SDG 4 – Quality Education

Mapped Topics / COs	Justification Highlight
Unit I: Digital Image Fundamentals	Builds conceptual clarity in image types, color models, and pixel operations.
CO1: Demonstrate image fundamentals	Develops foundational skills in visual data understanding, supporting education in STEM fields.

SDG 9 – Industry, Innovation, and Infrastructure

Mapped Topics / COs	Justification Highlight
Unit I–IV: All technical topics	Digital image processing is fundamental to automation, AI, robotics, and smart infrastructure design.
CO1 to CO6: All COs	Promote innovation through technical skills in image manipulation, recognition, and optimization.
Image Compression (Unit IV)	Crucial for data transmission in IoT, mobile devices, and satellite systems.
Color Model Conversion (Unit I)	Enables computer vision applications like autonomous driving and industrial inspection.

SDG 11 – Sustainable Cities and Communities

Mapped Topics / COs	Justification Highlight
Unit III: Image Restoration	Restores clarity in urban planning images (e.g., satellite, drone footage).
Unit IV: Image Segmentation	Used in identifying infrastructure (roads, buildings) in smart city projects.
CO4: Apply restoration techniques	Helps in noise-free aerial surveillance for disaster response.
CO5: Execute segmentation techniques	Enables mapping and monitoring of urban structures and resource allocation.

Signature of the course coordinator

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Mapping of Introduction to IoT to the UN Sustainable Development Goals (SDGs)

Course Title: Introduction to IoT

Course Code: 21OE002 Academic Year: 2024-25

Course Structure: 3-0-0-3

Course Coordinator: Dr.N. Chandrasekhar

Unit & Key Topics	**SDG(s)**	**Justification**
I. **Fundamentals & Mechanisms-** History, definitions, architecture, identification, security & privacy, smart-object paradigm	SDG 4 Quality Education SDG 9 Industry, Innovati on & Infrastructure	*SDG 4*: Builds foundational digital-systems literacy for students entering STEM careers. *SDG 9*: Lays the technical groundwork (architectures, scalability, interoperability) that underpins modern industrial IoT solutions and future infrastructure.
II. **From M2M to IoT** AVR Microcontroller- Value chains, market structure, design principles, MCU architecture & pins	SDG 8 Decent Work & E conomic GrowthSDG 9 I ndustry, Innovation & Inf rastructure	*SDG 8*: Examines IoT/M2M value chains and emerging markets, preparing graduates for new job roles and entrepreneurial opportunities. *SDG 9*: Teaches hardware–software co-design and standards needed to build robust IoT infrastructure.
III. **IoT Reference Architecture & Building Automation-** Functional/Information views, design constraints, enterprise Web-of-Things, commercial building case studies	SDG 7 Affordable & Clea n EnergySDG 9 Industry, Innovation & Infrastructu reSDG 11 Sustainable Cit ies & Communities	*SDG 7*: Emphasises energy-efficient designs (e.g., smart buildings, demand response). *SDG 9*: Develops multi-layer reference models essential for industrial IoT deployments. *SDG 11*: Uses building-automation case studies that increase urban resilience and sustainability.
IV. **IoT Business Applications** Hands-on- Smart grid, city automation, healthcare, transport, waste, sensor-social-web demos	SDG 3 Good Health & W ell-beingSDG 7 Affordab le & Clean EnergySDG 1 1 Sustainable Cities & Co mmunitiesSDG 12 Respo nsible Consumption & Pr	*SDG 3*: Smart-healthcare and medical monitoring use cases. *SDG 7*: Smart-grid and smart-metering labs optimise energy use.

	oductionSDG 13 Climate Action	*SDG 11*: City automation, smart transport, and waste-management demos directly improve urban life. *SDG 12*: Real-time data enables resource-efficient processes (e.g., process automation, smart cards).*SDG 13*: IoT-based environmental sensing supports data-driven climate-mitigation strategies.

Course-Outcome (CO) to SDG Mapping

CO	Statement	Aligned SDG(s)	Justification
1	Abstract the basic concepts of IoT	**SDG 4, SDG 9**	Foundational knowledge enriches engineering education (4) and is prerequisite for innovative infrastructure design (9).
2	Summarise the structural knowledge of IoT	**SDG 4, SDG 9**	Mastery of architecture/structure supports advanced study (4) and system-level innovation (9).
3	Exemplify M2M in the IoT context	**SDG 8, SDG 9**	Understanding value chains and inter-device workflows readies students for new tech-sector jobs (8) and fosters industrial IoT innovation (9).
4	Infer the IoT Reference Architecture	**SDG 9, SDG 11**	Designing layered architectures advances resilient infrastructure (9) and underpins smart-city solutions (11).
5	Interpret IoT systems for a given problem	**SDG 7, SDG 11, SDG 12**	Applying IoT to energy, city, and resource-efficiency problems drives clean energy use (7), sustainable urban services (11), and responsible production/consumption (12).
6	Find IoT solutions for various engineering applications	**SDG 3, SDG 7, SDG 11, SDG 12, SDG 13**	Broad application scope covers health monitoring (3), energy optimisation (7), smart-city infrastructure (11), waste-reduction processes (12), and climate-data analytics (13).

Highlighted justifications for each Sustainable Development Goal (SDG) mapped to the Introduction to IoT

🌍 SDG 3 – Good Health and Well-being

IoT enables real-time monitoring, diagnosis, and management of health systems.

- Smart Healthcare Applications in Unit IV support early detection and patient monitoring.
- IoT sensors used for remote health diagnostics, patient data transmission, and elderly care.
- Supports the design of automated health monitoring systems for hospitals and clinics.

📓 SDG 4 – Quality Education

Promotes digital literacy, technical competence, and problem-solving skills among students.

- Units I & II build strong foundational understanding of IoT architecture, frameworks, and microcontrollers.
- Students engage in practical, hands-on IoT training, enhancing employability and technical know-how.
- Encourages interdisciplinary learning by combining electronics, communication, and computing.

⚡ SDG 7 – Affordable and Clean Energy

IoT helps optimize energy consumption and supports smart energy grids.

- Unit IV applications include smart grid, smart metering, and energy-efficient building automation.
- Real-time control of power usage, reducing waste and promoting renewable integration.
- Supports demand-side energy management systems via IoT-based sensors.

💼 SDG 8 – Decent Work and Economic Growth

Develops workforce-ready skills and opens avenues for tech-driven entrepreneurship.

- Unit II explores IoT market structures, value chains, and emerging global trends.
- Prepares students for next-gen jobs in embedded systems, automation, and smart industries.
- Facilitates start-up culture in IoT-based innovation and manufacturing.

🏗 SDG 9 – Industry, Innovation, and Infrastructure

IoT is a cornerstone for smart, efficient, and resilient industrial systems.

- Units I to IV focus on IoT architecture, protocols, interoperability, and microcontroller integration.

- Emphasizes smart systems design, enabling intelligent manufacturing and digital transformation.
- Encourages standards-based development of scalable IoT solutions for global industries.

🏙 SDG 11 – Sustainable Cities and Communities

IoT solutions improve urban efficiency, resilience, and citizen services.

- Unit IV includes smart city, smart transport, waste management, and building automation.
- Encourages development of safe, efficient urban infrastructure using sensor networks.
- Enables data-driven governance and planning for sustainable development.

🔄 SDG 12 – Responsible Consumption and Production

IoT improves resource efficiency and enables real-time monitoring of consumption.

- Smart metering and process monitoring reduce water, energy, and material waste.
- Promotes efficient supply chains and production processes through IoT analytics.
- IoT supports predictive maintenance, reducing equipment failure and resource use.

🌱 SDG 13 – Climate Action

IoT provides real-time environmental data to support mitigation and adaptation strategies.

- Environmental sensors in IoT systems track air quality, CO_2 levels, and pollution.
- Supports early warning systems for climate-related disasters (e.g., floods, fires).
- Enables low-carbon technologies through smart energy and transportation systems.

Signature of the course coordinator

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Image Processing Mapping to Sustainable Development Goals (SDGs)

B.Tech (ECE) – 6th Semester

Course Title : **Image Processing**

Course Code : 21ECC32 Academic Year: 2024-2025

Course Structure: 3-0-2-4

Course Coordinator : Dr.N.Chandrasekhar

Instructors : Dr.N.Chandrsekhar

Unit	Topic(s)	Mapped SDG(s)	Justification
I	Digital Image Fundamentals, Color Models, Image Conversion	**SDG 4** – Quality Education **SDG 9** – Industry, Innovation & Infrastructure	Enhances students' foundational knowledge in image processing, promoting innovation and digital skills essential for modern industries and research.
II	Image Enhancement – spatial & frequency domain	**SDG 3** – Good Health & Well-Being **SDG 9** – Industry, Innovation & Infrastructure	Image enhancement techniques are widely used in medical imaging (X-ray, MRI) for improved diagnosis, contributing to health and technological advancement.
III	Image Restoration – noise removal, inverse filtering	**SDG 3** – Good Health & Well-Being **SDG 11** – Sustainable Cities & Communities	Restoration improves clarity in satellite and surveillance images for disaster response and urban planning, impacting safety and sustainable city development.
IV	Image Segmentation & Compression – thresholding, Huffman, transform coding	**SDG 9** – Industry, Innovation & Infrastructure **SDG 12** – Responsible Consumption & Production	Compression enables efficient storage and transmission of image data, supporting sustainable resource use and innovation in digital communication and AI systems.

Course Outcome (CO)	Mapped SDG(s)
CO1: Demonstrate the Basic image Operations and fundamental concepts.	**SDG 4** – Quality Education **SDG 9** – Industry, Innovation & Infrastructure
CO2: Execute various conversion operations on digital images.	**SDG 9** – Industry, Innovation & Infrastructure
CO3: Implement image enhancement techniques in spatial and frequency domain.	**SDG 3** – Good Health & Well-Being **SDG 9** – Industry, Innovation & Infrastructure
CO4: Implement various filters for image restoration.	**SDG 3** – Good Health & Well-Being **SDG 11** – Sustainable Cities & Communities
CO5: Execute segmentation techniques for digital images.	**SDG 11** – Sustainable Cities & Communities **SDG 3** – Good Health & Well-Being
CO6: Implementation of image lossless and lossy compression techniques.	**SDG 12** – Responsible Consumption & Production **SDG 9** – Industry, Innovation & Infrastructure

Justification Highlights

SDG 3 – Good Health and Well-Being

Mapped Topics / COs	Justification Highlight
Unit II: Image Enhancement	Used in medical imaging (e.g., MRI, X-ray) to enhance image clarity for accurate diagnosis.
Unit III: Image Restoration	Removes noise from medical and biomedical images to assist in better clinical interpretation.
CO3: Implement enhancement techniques	Critical for improving image quality in health diagnostics.
CO4: Apply filters for image restoration	Enhances readability of medical and pathological scans.
CO5: Apply segmentation techniques	Enables precise organ or tumor identification in medical imaging systems.

SDG 4 – Quality Education

Mapped Topics / COs	Justification Highlight
Unit I: Digital Image Fundamentals	Builds conceptual clarity in image types, color models, and pixel operations.
CO1: Demonstrate image fundamentals	Develops foundational skills in visual data understanding, supporting education in STEM fields.

SDG 9 – Industry, Innovation, and Infrastructure

Mapped Topics / COs	Justification Highlight
Unit I–IV: All technical topics	Digital image processing is fundamental to automation, AI, robotics, and smart infrastructure design.
CO1 to CO6: All COs	Promote innovation through technical skills in image manipulation, recognition, and optimization.
Image Compression (Unit IV)	Crucial for data transmission in IoT, mobile devices, and satellite systems.
Color Model Conversion (Unit I)	Enables computer vision applications like autonomous driving and industrial inspection.

SDG 11 – Sustainable Cities and Communities

Mapped Topics / COs	Justification Highlight
Unit III: Image Restoration	Restores clarity in urban planning images (e.g., satellite, drone footage).
Unit IV: Image Segmentation	Used in identifying infrastructure (roads, buildings) in smart city projects.
CO4: Apply restoration techniques	Helps in noise-free aerial surveillance for disaster response.
CO5: Execute segmentation techniques	Enables mapping and monitoring of urban structures and resource allocation.

Signature of the course coordinator

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Mapping of Principles of Data Science to the UN Sustainable Development Goals

Course Title: Principles of Data Science.

Course Code: 23OE016 Academic Year: 2025-26

Course Structure: 3 0 0 3

Course Coordinator: Dr. N. Chandrasekhar

Unit-wise Mapping to Sustainable Development Goals (SDGs)

Unit/Topics	**Mapped SDG(s)**	**Justification Highlight**
Unit I Introduction to Data Science, Data Exploration, Visualization, Algorithm Categories	SDG 4 – Quality Education SDG 9 – Industry, Innovation & Infrastructure	Builds foundational understanding of data handling and visualization, crucial for STEM education and data-driven industry applications.
Unit II Data Similarity & Preprocessing	SDG 9 – Industry, Innovation & Infrastructure SDG 12 – Responsible Consumption & Production	Ensures clean, accurate data pipelines that support efficient, sustainable data-driven systems in business, health, and governance.
Unit III Regression & Classification	SDG 3 – Good Health & Well-Being SDG 8 – Decent Work & Economic Growth SDG 9 – Industry, Innovation & Infrastructure	Supports predictive modeling for health diagnostics, finance, agriculture, and hiring processes. Promotes innovation and career-readiness.
Unit IV Ensemble Learning & Clustering	SDG 11 – Sustainable Cities & Communities SDG 13 – Climate Action SDG 9 – Industry, Innovation & Infrastructure	Enables data-driven insights for urban planning, energy optimization, customer segmentation, and climate monitoring using ensemble and clustering models.

Course Outcome (CO) to SDG Mapping with Justification

CO	Course Outcome	Mapped SDG(s)	Justification
CO1	Understand the pipeline of data science and real-world applications	SDG 4, SDG 9	Promotes education in cutting-edge tools; supports data-driven innovation in industries.
CO2	Understand measuring similarity/dissimilarity	SDG 9, SDG 12	Supports pattern recognition in smart systems and efficient use of data resources.
CO3	Explain data preprocessing for real-time scenarios	SDG 9, SDG 12	Enables high-quality data workflows that reduce redundancy and support sustainable digital processes.
CO4	Identify regression model applications	SDG 3, SDG 8, SDG 9	Regression models are widely used in healthcare analytics, business forecasting, and R&D.
CO5	Apply classification models and assess performance	SDG 3, SDG 8, SDG 9	Helps in medical decision support systems, fraud detection, and industrial automation.
CO6	Understand ensemble modeling and clustering	SDG 11, SDG 13, SDG 9	Facilitates city-scale decisions, disaster risk assessment, and infrastructure improvements using grouped data insights.

🔍 Justification Highlights by SDG

SDG 3 – Good Health & Well-Being

- Regression and classification models (Unit III) used in medical diagnosis, predicting disease spread, patient risk analysis.
- Enables early warning systems and decision support in healthcare.

SDG 4 – Quality Education

- Develops data literacy and analytical thinking, preparing students for data-intensive careers.
- Includes visualization and exploratory techniques to understand and communicate insights.

SDG 8 – Decent Work & Economic Growth

- Regression, classification, and clustering are used in HR analytics, sales forecasting, and operational efficiency, boosting economic productivity.

SDG 9 – Industry, Innovation & Infrastructure

- Data science is foundational to AI-driven innovation, smart factories, and intelligent infrastructure.
- Data preprocessing, similarity measures, and modeling support industrial automation and digital transformation.

SDG 11 – Sustainable Cities & Communities

- Clustering and ensemble models help in urban segmentation, resource allocation, and smart infrastructure development.
- Applied in traffic analysis, housing pattern detection, and public safety systems.

SDG 12 – Responsible Consumption & Production

- Clean and transformed data ensures efficient use of storage, computing, and energy.
- Preprocessing enables optimized models that prevent data misuse and improve digital sustainability.

SDG 13 – Climate Action

- Clustering models help identify environmental patterns, pollution clusters, and climate risk zones.
- Supports data-driven environmental monitoring for informed policy actions.

Signature of the course coordinator

SDG Mapping for Computer Networks

Unit-wise SDG Mapping

Unit	Topic	Relevant SDG(s)	Justification
Unit I	Data Communication, Transmission Media, Switching	SDG 9 – Industry, Innovation and Infrastructure	Lays foundation for digital communication systems and network infrastructure.
Unit II	Data Link Layer, Protocols, CRC, Error Handling	SDG 9 – Industry, Innovation and Infrastructure	Crucial for ensuring reliable data transfer, foundational in telecom and industrial control systems.
Unit III	Network Layer, Routing, Congestion Control	SDG 9 – Industry, Innovation and Infrastructure SDG 11 – Sustainable Cities and Communities	Routing algorithms and QoS mechanisms are essential in smart cities, traffic management, and sensor networks.
Unit IV	Transport and Application Layer, TCP/IP, HTTP	SDG 9 – Industry, Innovation and Infrastructure	Supports digital economy via secure and efficient protocols enabling web services, IoT, and e-governance.

Justification Highlights by SDG

1. SDG 9: Industry, Innovation, and Infrastructure
Computer Networks provide the backbone for modern infrastructure—enabling innovations in IT, automation, cloud computing, and telecommunications.

2. SDG 11: Sustainable Cities and Communities
Efficient networking protocols and technologies support smart transportation, city-wide surveillance, environmental monitoring, and public connectivity.

Course Outcomes to SDG Mapping

Course Outcome	Mapped SDG(s)
CO1 – Illustrate the knowledge of the basic Data Communication System and Computer Network Systems	SDG 9
CO2 – Classify various wired and wireless transmission media for data communication networks	SDG 9
CO3 – Demonstrate different techniques of error detection and correction to detect and solve error bit during data transmission	SDG 9
CO4 – Illustrate the routing mechanisms and congestion issues in network design	SDG 9, SDG 11
CO5 – Experiment with different network tools	SDG 9
CO6 – Summarize the internal functionalities of main protocols such as HTTP, SNMP, TCP, UDP, IP	SDG 9

SDG Mapping for Analog and Digital Communications Lab

Course Outcome	Mapped SDG(s)	Justification
CO1 – Assess the sampling theorem	SDG 4 – Quality Education SDG 9 – Industry, Innovation and Infrastructure	Understanding sampling theorem is foundational for all digital communication, enabling development of reliable data acquisition systems and supporting high-quality education in telecommunications.
CO2 – Demonstrate modulation techniques	SDG 9 – Industry, Innovation and Infrastructure SDG 11 – Sustainable Cities and Communities	Modulation techniques underpin modern wireless and wired communication infrastructure essential for smart cities, public services, and industrial networks.
CO3 – Demonstrate demodulation techniques	SDG 9 – Industry, Innovation and Infrastructure	Demodulation is critical for receiving and decoding signals in telecommunications, supporting innovation in broadband, satellite, and IoT systems.
CO4 – Implement different Baseband modulation techniques	SDG 9 – Industry, Innovation and Infrastructure SDG 13 – Climate Action	Baseband modulation increases communication efficiency, reduces power consumption, and enables energy-aware system designs that lower the carbon footprint.
CO5 – Demonstrate different Digital modulation techniques	SDG 9 – Industry, Innovation and Infrastructure SDG 11 – Sustainable Cities and Communities	Digital modulation facilitates high-speed data communication for smart infrastructure, disaster management, and connected communities.
CO6 – Contrast the design issues in a digital communication system	SDG 9 – Industry, Innovation and Infrastructure SDG 13 – Climate Action	Critical evaluation of design issues promotes the development of robust, efficient, and sustainable communication systems that support climate monitoring and minimize environmental impact.

Justification Highlights by SDG

SDG 4: Quality Education

- Core communication concepts empower students with skills necessary for careers in modern telecommunication industries.

SDG 9: Industry, Innovation, and Infrastructure

- All outcomes contribute to resilient, inclusive, and sustainable communication infrastructure supporting digital transformation.

SDG 11: Sustainable Cities and Communities

- Advanced modulation and reliable communication are essential for smart grids, emergency services, and urban resilience.

SDG 13: Climate Action

- Energy-efficient communication systems help reduce emissions and support environmental monitoring networks.

Course Outcome	Mapped SDG(s)
1. Assess the sampling theorem	SDG4, SDG 9
2. Demonstrate modulation	SDG 9, SDG 11
3. Demonstrate demodulation	SDG 9
4. Implement different Baseband modulation techniques	SDG 9, SDG13
5. Demonstrate different Digital modulation techniques	SDG 9, SDG 11
6. Contrast the design issues in a digital communication system	SDG 9, SDG 13

SDG Mapping for Analog and Digital Communications

Unit	Topic	Relevant SDG(s)	Justification
Unit I Amplitude modulation and frequency modulation	Basic Concepts of Analog Communication (modulation DSBSC, Frequency modulation, bandwidth)	SDG 9 – Industry, Innovation and Infrastructure	Foundational knowledge enables robust telecommunication networks essential for modern infrastructure and industrial innovation.
Unit II Noise, Analog transmitters and receivers	Noise & its analysis, Pre-emphasis & de-emphasis, Transmitter & Receiver	SDG 9 – Industry, Innovation and Infrastructure SDG 11 – Sustainable Cities and Communities	AM/FM systems underpin radio communication for disaster management, public broadcasting, and community connectivity in the cities
Unit III Pulse Modulation	Digital communication system, Pulse Code Modulation, Sampling Theorem, Quantization	SDG 9 – Industry, Innovation and Infrastructure SDG 4 – Quality Education	Digital encoding and PCM are essential for data transmission for banking, shopping, etc. e-learning platforms, tele-education, and accessible information sharing
Unit IV Digital modulations & Information theory	Digital Modulation Techniques (ASK, FSK, PSK, QAM) Error Control Coding, Data Compression	SDG 9 – Industry, Innovation and Infrastructure SDG 11- Sustainable Cities and Communities SDG 13 – Climate Action	Digital modulation supports high-speed wireless communication, IoT networks, and smart city services. Efficient data compression and error correction improve energy efficiency in communication infrastructure and reduce the carbon footprint of data centers.

Justification Highlights by SDG

1. SDG 4: Quality Education

Digital communication makes remote learning possible, expanding education access.

2. SDG 9: Industry, Innovation, and Infrastructure

All topics contribute to modern, resilient digital infrastructure (mobile networks, satellite communication, broadband). —key enablers of digital infrastructure.

3. SDG 11: Sustainable Cities and Communities

Reliable communication supports smart grids, emergency services, and intelligent transport systems.

4. SDG 13: Climate Action

Advanced coding and efficient communication protocols lower power consumption and support environmental monitoring networks.

Course Outcome	Mapped SDG(s)
CO1 – Explain Analog Modulation & Demodulation techniques	SDG 9
CO2 – Summarise the noise level in Analog communication systems	SDG 9, SDG 11
CO3 – Demonstrate the operations of Transmitters and Receivers	SDG 9
CO4 – Explain different pulse modulation techniques	SDG 9
CO5 – Illustrate different digital modulation and demodulation techniques	SDG 9, SDG 11
CO6 – Illustrate different error control codes techniques	SDG 9, SDG 13

SDG Mapping for Analog and mixed vlsi design Course

Unit	Topic	Relevant SDG(s)	Justification
Unit I	Basic Analog Circuits, MOS Modeling, Current Mirrors	**SDG 9** – Industry, Innovation, and Infrastructure	This unit builds foundational analog circuit design skills essential for modern electronics, semiconductors, and communication industries.
Unit II	Differential Amplifiers, Op-Amps, Cascode & Folded Cascode Architectures	**SDG 9**	Analog and Op-Amp designs are at the heart of instrumentation, control systems, and precision analog electronics used in industry and medical systems.
Unit III	Switched Capacitor Circuits, Filters	**SDG 9** and **SDG 11** – Sustainable Cities and Communities	Switched capacitor filters are integral in low-power, compact signal processing systems used in wireless communication, sensor networks, and smart city applications.
Unit IV	Data Converters (ADC/DAC), Bandgap References	**SDG 9** and **SDG 7** – Affordable and Clean Energy	Data converters are key components in IoT, energy metering, and renewable energy monitoring systems, enabling energy-efficient digital interfacing and control.

Course Outcome (CO) – SDG Mapping

CO No.	Course Outcome	Mapped SDG(s)	Justification
CO1	Illustrate MOS device models, single-stage amplifiers, and current mirrors	**SDG 9**	Supports innovation in semiconductor and analog chip industries
CO2	Explain the operation of differential amplifiers	**SDG 9**	Essential for advanced circuit design in industrial and biomedical electronics
CO3	Demonstrate the operation of Op-amp internal circuits	**SDG 9**	Enables development of precision analog systems for critical applications
CO4	Demonstrate the operation of switched capacitor circuits	**SDG 9**, **SDG 11**	Useful for smart devices in urban infrastructure and low-power designs
CO5	Demonstrate the operation of continuous and discrete-time filters	**SDG 9**, **SDG 11**	Core to signal conditioning in communications and environmental monitoring
CO6	Outline the operation of data conversion circuits	**SDG 7**, **SDG 9**	Vital for interfacing energy and industrial systems with digital control units

Justification Highlights by SDG

SDG 7: Affordable and Clean Energy

- Analog-to-Digital (ADC) and Digital-to-Analog Converters (DAC) are essential in renewable energy monitoring, smart meters, and energy-efficient embedded systems.
- Bandgap reference circuits and time-interleaved ADCs contribute to low-power, high-efficiency signal processing in clean energy systems.

SDG 9: Industry, Innovation, and Infrastructure

- The course enables students to design fundamental and advanced analog building blocks (MOS amplifiers, Op-Amps, current mirrors), which are critical in semiconductor and VLSI industries.
- Switched capacitor circuits and filters are essential in low-power analog signal processing for communication, automotive, and biomedical applications.
- Data converter design fosters innovation in IoT systems, control systems, and embedded electronics, supporting industrial automation and infrastructure growth.

SDG 11: Sustainable Cities and Communities

- Switched-capacitor filters and low-power analog circuits are key enablers of smart sensor systems used in traffic management, air quality monitoring, and urban infrastructure.
- Analog front-end circuits designed using course concepts are applied in environmental sensing and public safety systems that support sustainable urban development.

SDG Mapping for Antennas and Microwave Engineering

Unit	Topic	Relevant SDG(s)	Justification
Unit IAntenna Fundamentals & Arrays	Radiation mechanism, antenna parameters, arrays, beam patterns, LiDAR	SDG 9 – Industry, Innovation and Infrastructure	Antenna design contribute to innovations in communication and environmental monitoring
Unit II Parasitic Elements & Special Antennas	Yagi-Uda, Folded Dipoles, Reflectors, Helical, Horn, Patch, Log-Periodic Antennas	SDG 9 – Industry, Innovation and Infrastructure SDG 11 – Sustainable Cities and Communities	Patch and log-periodic antennas are key in wireless networks, smart cities, and IoT infrastructure. Microstrip antennas are essential in portable, energy-efficient communication systems.
Unit III Waveguides & Components	Rectangular waveguides, TE/TM modes, S-parameters, Couplers, Isolators, Circulators	SDG 9 – Industry, Innovation and Infrastructure	Waveguide theory supports advanced radar and satellite systems used in navigation, earth observation, and telemedicine.
Unit IV Microwave Tubes & Measurements	Klystron, Reflex Klystron, Magnetron, Gunn/Impatt Diodes, Measurements	SDG 7 – Affordable and Clean Energy SDG 9 – Industry, Innovation and Infrastructure	Microwave tubes are used in plasma generation, medical diagnostics, and energy systems.- Measurements support precise communication systems used in renewable energy management (e.g., wind/solar).

Justification Highlights by SDG

1. SDG 7: Affordable and Clean Energy

Microwave systems (magnetrons, diodes) are used in wireless power transmission, smart grid monitoring, and microwave-assisted chemical processing, contributing to cleaner energy systems.

2. SDG 9: Industry, Innovation, and Infrastructure

The entire course fosters innovative designs for telecommunications, space tech, radar systems, and wireless communication—key enablers of digital infrastructure.

3. SDG 11: Sustainable Cities and Communities

Smart antennas and arrays are vital in developing smart city networks, traffic control systems, and urban sensing platforms.

Course Outcome	Mapped SDG(s)
CO1 – Illustrate parameters of an antenna and antenna arrays	SDG 9
CO2 – Implement antenna arrays	SDG 9, SDG 11
CO3 – Design an antenna for given specifications	SDG 9
CO4 – Justify modes of rectangular waveguide and the S-parameters of waveguide components	SDG 9
CO5 – Summarize operation of microwave tubes	SDG 7, SDG 9
CO6 – Interpret microwave measurements	SDG 7, SDG 9

SDG Mapping for ASIC Verification using System Verilog Course

Unit	Topic	Relevant SDG(s)	Justification
Unit I	Introduction to Verification and Data Types	**SDG 9 –** Industry, Innovation, and Infrastructure	Foundational skills for digital IC design and verification, supporting innovation in the semiconductor industry.
Unit II	Assertions and Routines	**SDG 9**	Enhances test reliability and functional safety in electronic systems development.
Unit III	Basic OOPs	**DG 4 –** Quality Education**, SDG 9**	Promotes technical and software-oriented skills, enabling complex verification strategies in digital design.
Unit IV	Connecting the Test bench and Design	**SDG 9, SDG 11 –** Sustainable Cities and Communities	Verification of smart systems and digital infrastructure supporting urban automation and EDA-based innovation.

Course Outcome (CO) – SDG Mapping

CO No.	Course Outcome	Mapped SDG(s)	Justification
CO1	Interpret the verification guidelines and data types	**SDG 9**	Critical for efficient and innovative hardware verification.
CO2	Execute the programs using assertions and Routines.	**SDG 9**	Enables robust hardware and system validation practices.
CO3	Demonstrate the System Verilog constructs through simulations	**SDG 4, SDG 9**	Builds simulation skills essential in modern EDA workflows.
CO4	Explain the basic OOPs concepts.	**SDG 4**	Enhances digital skills and object-based coding understanding.
CO5	Organize the design modules in SV test bench.	**SDG 9**, **SDG 11**	Supports modular and reusable testbench development for smart and sustainable systems.
CO6	Exemplify the ASIC verification using SV testbench	**SDG 9**	Strengthens industry-relevant skills for semiconductor innovation.

Justifications for each SDG highlighted

SDG 4 – Quality Education

- Promotes advanced learning of coding, simulation, and object-oriented concepts using System Verilog.
- Encourages hands-on practical skills through lab components and simulation-based assignments.
- Develops critical thinking and abstraction skills through use of classes, tasks, functions, and testbench design.
- Prepares students for lifelong learning and professional development in VLSI and EDA industries.

SDG 7 – Affordable and Clean Energy *(Indirectly related through testbench verification of energy-aware systems)*

- SV-based verification skills can be applied to low-power digital designs and energy-efficient embedded systems.
- Supports development of smart energy systems, where precise simulation and verification of control logic is essential.
- Encourages testing of energy-saving architectures through reusable verification environments.

SDG 9 – Industry, Innovation, and Infrastructure

- Equips students with skills to work in semiconductor and VLSI industries.
- Teaches automated verification methodologies (like UVM), widely adopted in the hardware industry.
- Enhances capabilities in debugging and verifying complex digital systems, fostering innovation in ASIC design.
- Strengthens knowledge of System Verilog, a standard tool used in hardware modeling and testing worldwide.
- Encourages industry-relevant practices like layered testbenches, assertions, and simulation tools.

SDG 11 – Sustainable Cities and Communities

- Enables development of verified and reliable smart electronics, used in urban infrastructure (e.g., traffic control, public safety).
- Supports simulation of IoT-based systems used in smart city applications.
- Promotes design of modular and scalable verification testbenches, which are key in developing sustainable digital systems for smart homes and transport.

SDG Mapping for Cellular Mobile Communication (21EC601)

Unit	Topic	Relevant SDG(s)	Justification
Unit I Introduction to Cellular Systems	Cellular concepts, frequency reuse, interference, trunking	**SDG 9 – Industry, Innovation and Infrastructure**	Concepts of frequency planning and interference management form the backbone of reliable mobile infrastructure.
Unit II Mobile Radio Propagation	Large-scale path loss, shadowing, small-scale fading	**SDG 9 – Industry, Innovation and InfrastructureSDG 11 – Sustainable Cities and Communities**	Understanding radio propagation is essential for dense urban networks, smart transportation, and public safety systems.
Unit III Modulation & Multiple Access Techniques	FDMA, TDMA, CDMA, OFDMA, spectral efficiency	**SDG 9 – Industry, Innovation and Infrastructure**	These techniques are central to efficient spectrum usage, enabling mass connectivity and next-gen mobile broadband.
Unit IV Handoffs & Capacity	Handoff strategies, capacity improvement, cell splitting	**SDG 9 – Industry, Innovation and Infrastructure** **SDG 11 – Sustainable Cities and Communities**	Efficient handoffs and capacity expansion are vital for uninterrupted service in urban mobility scenarios.
Unit V Advanced Cellular Systems	3G/4G/5G technologies, multiple antenna techniques, LTE features	**SDG 9 – Industry, Innovation and Infrastructure** **SDG 11 – Sustainable Cities and Communities**	Advanced mobile systems enable high-speed connectivity, IoT integration, and smart city applications.

Justification Highlights by SDG

- **SDG 9: Industry, Innovation, and Infrastructure**

  The entire course equips students with foundational knowledge of mobile networks, which are critical for modern digital infrastructure, rural connectivity, and economic development.

- **SDG 11: Sustainable Cities and Communities**

  Advanced handoff, capacity optimization, and cellular design techniques directly contribute to building resilient and sustainable communication systems in cities — enabling smart transportation, emergency response, and connected communities.

Course Outcome Mapped SDG(s)

Course Outcome	**Mapped SDG(s)**
CO1 – Explain basic cellular concepts and frequency reuse	SDG 9
CO2 – Analyze radio propagation mechanisms affecting mobile communication	SDG 9, SDG 11
CO3 – Compare modulation and multiple access schemes	SDG 9
CO4 – Evaluate handoff strategies and methods for increasing cellular capacity	SDG 9, SDG 11
CO5 – Summarize evolution and features of advanced mobile systems (3G/4G/5G)	SDG 9, SDG 11

SDG Mapping for Electronic Devices and Circuits

Unit-wise SDG Mapping

Unit	Topic	Relevant SDG(s)	Justification
Unit I: Semiconductors–Diodes	PN Junction, Zener, Tunnel, Photo, LED; UJT, SCR; Rectifiers, Filters, Regulators	SDG 9 – Industry, Innovation and Infrastructure	Semiconductor diodes are fundamental in all modern electronic equipment, enabling reliable and efficient circuit design.
Unit II: BJT & FET	BJT characteristics, amplifier configurations, biasing, JFET & MOSFET characteristics	SDG 9 – Industry, Innovation and Infrastructure	Transistors are the backbone of electronic amplification and switching in communications, control, and computing systems.
Unit III: Low Frequency Amplifiers	Single stage amplifiers, h-parameters, CE, CB, CC and FET configurations	SDG 9 – Industry, Innovation and Infrastructure	Low-frequency amplifier design enables innovation in signal processing, audio, and sensor electronics.
Unit IV: High Frequency and Multi Stage Amplifiers	Hybrid model, frequency response, cascaded amplifiers, Darlington, Cascode	SDG 9 – Industry, Innovation and Infrastructure	High-frequency amplifier systems are vital for advanced communication and radar infrastructure.

Justification Highlights by SDG

1. **SDG 9**: Industry, Innovation, and Infrastructure
   Modern electronic devices and amplifiers are core enablers of innovation in telecommunications, control systems, sensor networks, and embedded systems. This course empowers students with the foundational design knowledge essential for building resilient infrastructure and digital systems.

Course Outcome Mapped SDG(s)

Course Outcome	Mapped SDG(s)
CO1 – Explain characteristics and applications of semiconductor devices	SDG 9
CO2 – Illustrate the characteristics of transistors	SDG 9
CO3 – Construct different biasing circuits for BJT	SDG 9
CO4 – Illustrate h-parameter representation and Hybrid-model of transistor	SDG 9
CO5 – Analyse low frequency and high frequency single stage amplifiers	SDG 9
CO6 – Construct multi stage amplifiers	SDG 9

SDG Mapping for Electromagnetic Fields and Transmission Lines

Unit-wise SDG Mapping

Unit	Topic	Relevant SDG(s)	Justification
Unit I	Static Electric and Magnetic Fields, Gauss Law, Ampere's Law, Capacitance, Inductance	SDG 9 – Industry, Innovation and Infrastructure	Fundamentals of electromagnetics support the development of communication, sensor, and energy systems infrastructure.
Unit II	Maxwell's Equations, Wave Equations, EM Wave Propagation in Media	SDG 9 – Industry, Innovation and Infrastructure	Maxwell's equations are foundational for wave-based applications like wireless communication, radar, and energy-efficient designs.
Unit III	EM Wave Characteristics, Reflection/Refraction, Poynting Theorem	SDG 9 – Industry, Innovation and Infrastructure	Understanding wave interaction with media aids in developing smart antennas and efficient wireless systems.
Unit IV	Transmission Lines, Impedance Matching, Smith Chart	SDG 9 – Industry, Innovation and Infrastructure	Transmission line theory is essential for high-frequency system design in telecommunications and modern electronics.

Course Outcome – SDG Mapping

Course Outcome	Mapped SDG(s)	Justification
CO1 – Demonstrate the laws & theorems of static electric and magnetic fields	SDG 9	Provides the basis for developing advanced electronics and electromagnetic devices.
CO2 – Demonstrate the behaviour of time-varying electromagnetic fields using Maxwell's equations	SDG 9	Enables analysis of dynamic fields, crucial for wireless, radar, and optical communication systems.
CO3 – Outline the electromagnetic wave	SDG 9	Essential for designing systems in

propagation in different media		telecommunications, satellite, and fiber-optic technologies.
CO4 – Demonstrate the characteristics of EM waves	SDG 9	Key to understanding wave-material interaction used in medical, security, and remote sensing fields.
CO5 – Illustrate the parameters of transmission lines	SDG 9	Transmission line knowledge is vital for circuit design in high-speed and RF systems.
CO6 – Outline the impedance transformation techniques	SDG 9	Critical for designing efficient matching networks and minimizing signal loss in electronic systems.

SDG Mapping for Embedded System Design and IoT (21ECC22)

Unit-wise SDG Mapping

Unit	Topic	Relevant SDG(s)	Justification
Unit I	Embedded Systems: Architecture, Boards, Interfaces	**SDG 4** – Quality Education **SDG 9** – Industry, Innovation, and Infrastructure	Introduces students to modern embedded system architecture and communication interfaces, promoting technical literacy and innovation.
Unit II	Firmware and Hardware Development	**SDG 4** – Quality Education **SDG 8** – Decent Work and Economic Growth SDG 9 – Industry, Innovation, and Infrastructure	Develops hardware-software integration and debugging skills, enhancing job readiness and industry-oriented learning.
Unit III	IoT Architecture and Sensors	**SDG 4** – Quality Education **SDG 9** – Industry, Innovation, and Infrastructure **SDG 11** – Sustainable Cities and Communities	Focuses on real-world sensing and IoT applications that contribute to smart infrastructure and sustainable city development.
Unit IV	IoT Web Services and Applications	**SDG 4** – Quality Education **SDG 9** – Industry, Innovation, and Infrastructure	Covers cloud platforms, real-time data integration, and smart

		SDG 11 – Sustainable Cities and Communities **SDG 13 –** Climate Action	applications, supporting climate-responsive urban planning and innovation.

Course Outcome (CO) – SDG Mapping

Course Outcome	Mapped SDG(s)
CO1 – Interpret embedded system architecture	SDG 4, SDG 9
CO2 – Demonstrate embedded target boards and firmware development	SDG 4, SDG 8, SDG 9
CO3– Demonstrate interfacing of IO devices	SDG 4, SDG 9
CO4 – Illustrate various IoT characteristics and architectures	SDG 4, SDG 9, SDG 11
CO5 – Assess real world parameters for IoT applications	SDG 4, SDG 9, SDG 13
CO6 – Design prototype embedded systems using IoT	SDG 4, SDG 9, SDG 11

Justification Summary for Mapped SDGs

SDG 4 – Quality Education

- Enhances technical literacy through embedded systems and IoT skills.
- Hands-on projects and lab sessions promote experiential learning.

SDG 8 – Decent Work and Economic Growth

- Develops industry-relevant skills in firmware and embedded hardware design.
- Encourages entrepreneurship and job readiness in the electronics and IoT sectors.

SDG 9 – Industry, Innovation, and Infrastructure

- Promotes knowledge of smart systems, communication protocols, and IoT infrastructure.
- Strengthens innovation through prototype development and cloud-based applications.

SDG 11 – Sustainable Cities and Communities

- Supports the development of smart, sensor-driven infrastructure.
- IoT projects contribute to smart transportation, waste management, and public utilities.

SDG 13 – Climate Action

- Sensor-based systems help in monitoring and mitigating environmental impact.
- IoT applications can support climate-adaptive urban planning and agriculture.

SDG Mapping for – Fundamentals of Image Processing

Unit	Topic	Relevant SDG(s)	Justification
Unit I	Digital Image Fundamentals, Color Image Enhancement	**SDG 9 – Industry, Innovation, and Infrastructure**	Image processing fundamentals and color enhancement are essential in industrial automation, medical imaging, and remote sensing systems.
Unit II	Image Transforms (DFT, DCT, DWT), Image Enhancement	**SDG 9 – Industry, Innovation, and Infrastructure SDG 11 – Sustainable Cities and Communities**	Transforms and enhancement methods are used in image compression, video streaming, and smart surveillance systems for urban development.
Unit III	Image Restoration	**SDG 3 – Good Health and Well-being SDG 9**	Restoration techniques improve diagnostic imaging (e.g., MRI, X-ray), enhancing medical decision-making and innovation.
Unit IV	Image Segmentation and Compression	**SDG 3 – Good Health and Well-being SDG 9SDG 11**	Segmentation supports applications in healthcare, autonomous vehicles, and smart cities; compression is vital for communication systems.

CO-wise SDG Mapping for 21OE003 – Fundamentals of Image Processing

CO No.	Course Outcome	Mapped SDG(s)	Justification
CO1	Interpret the fundamental concepts of gray and color image processing	**SDG 9**	Core image processing concepts support applications in telecommunications, robotics, and digital infrastructure.
CO2	Infer image transforms	**SDG 9**, **SDG 11**	Transforms (DFT, DCT, and DWT) are foundational in multimedia, smart systems, and intelligent surveillance.
CO3	Exemplify image enhancement techniques in spatial and frequency domains	**SDG 9**, **SDG 11**	Enhancement is vital in smart city imaging, environmental monitoring, and industrial systems.
CO4	Illustrate image restoration techniques	**SDG 3**, **SDG 9**	Restoration methods improve quality of medical and industrial imaging systems.
CO5	Summarize line, point, threshold, and region-based segmentation	**SDG 3**, **SDG 11**	Image segmentation supports healthcare (MRI/CT analysis) and smart city technologies (traffic, safety).
CO6	Assess various compression models and techniques for digital images	**SDG 9**, **SDG 11**	Compression is critical for communication systems, mobile devices, and multimedia in smart environments.

Justification Highlights by SDG

SDG 3: Good Health and Well-being

- Image restoration and segmentation techniques are widely used in **medical image analysis** for diagnostics, surgical planning, and telemedicine.
- Improved visualization of biomedical images leads to **early disease detection and accurate diagnosis**.

SDG 9: Industry, Innovation, and Infrastructure

- The course empowers students with techniques that support **telecommunications**, **multimedia systems**, and **industrial robotics**.
- Algorithms like DCT/DWT are foundational in **image and video compression standards** (e.g., JPEG, MPEG).
- Key to innovations in **AI-driven visual systems**, **remote sensing**, and **automated inspection**.

SDG 11: Sustainable Cities and Communities

- Image processing underpins **smart surveillance, traffic monitoring, and urban planning**.
- Segmentation and enhancement improve **autonomous vehicle vision systems**, aiding in **safe and efficient urban mobility**.

Detailed SDG Mapping for Fundamentals of Machine Learning

Unit-wise SDG Mapping with Topics

Unit	Topic	Relevant SDG(s)	Justification
Unit I	Overview of Machine Learning	SDG 9	Supports innovation in AI-driven industrial systems and automation.
Unit I	Hypothesis Formulation and Model Selection	SDG 9	Enables predictive models for smart infrastructure and systems.
Unit I	Evaluation of ML Models and Bias-Variance Trade-off	SDG 9	Improves performance and reliability of industrial ML applications.
Unit I	Regression and Feature Selection	SDG 9	Essential for data-driven decision making in healthcare and energy management.
Unit II	Decision Trees and ID3 Classifier	SDG 9	Facilitates interpretable AI for sustainable industry applications.
Unit II	Bayesian Learning and Naive Bayes Classifier	SDG 9	Enhances reliability in medical diagnosis and risk assessment.
Unit II	Instance-based Learning and Nearest Neighbor	SDG 9	Enables real-time decision systems in transport and communication.

Unit II	Modelling Supervised Learning Systems	SDG 9	Supports automation in smart city and IoT systems.
Unit III	Clustering Techniques: K-Means and Hierarchical Clustering	SDG 9, SDG 11	Helps in urban planning, traffic management, and community analysis.
Unit III	Dimensionality Reduction: LDA and PCA	SDG 9	Simplifies complex data for better industrial AI systems.
Unit III	Ensemble Learning: Boosting and Bagging	SDG 9	Improves AI system resilience for industrial and environmental data.
Unit III	Curse of Dimensionality and Data Scaling	SDG 9	Enhances model accuracy and performance in predictive systems.
Unit IV	Artificial Neural Networks and MLP	SDG 9	Enables complex AI systems for healthcare, robotics, and finance.
Unit IV	Deep Learning: CNN and Object Recognition	SDG 9, SDG 11	Supports smart city surveillance and environmental monitoring.
Unit IV	Gradient Descent and Error Propagation	SDG 9	Optimizes learning systems for industrial applications.
Unit IV	XOR Gate and Linear Separability	SDG 9	Fundamental for AI model design in automated systems.

Course Outcomes Mapped to SDGs

Course Outcome	Mapped SDG(s)
CO1- Classify the variety of learning algorithms.	SDG 9
CO2 - Choose a learning algorithm to data using various tools of Machine Learning.	SDG 9
CO3 - Identify the strengths and weaknesses of many popular machine learning approaches.	SDG 9
CO4 - Examine the performance of learning algorithms and model selection.	SDG 9
CO5- Identify mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning.	SDG 9
CO6 - Model Artificial Neural Networks and Deep Neural Networks in solving complex real world problems.	SDG 9

SDG Mapping for IoT Architectures and Protocols

Unit	Topic	Relevant SDG(s)	Justification
Unit I Overview of IoT	IoT Conceptual Framework - Oracle, IBM and CISCO. IoT design standards (IETF, ITU-T,ETSI and OGC), Modified OSI model for the IoT/M2M systems proposed by IETF and ITU-T	**SDG 9** – Industry, Innovation, and Infrastructure **SDG 11** – Sustainable Cities and Communities	Understanding IoT frameworks and architectures is foundational for building smart, efficient systems. (SDG 9) Smart systems are vital in modern infrastructure, smart cities, and industrial innovation, contributing to sustainable urbanization and smart governance. (SDG 11)
Unit II Communication Technologies and IoT Protocols	Wireless communication technologies (Zigbee and Bluetooth/BLE), Wired communication technologies (SPI and I2C), Constrained Applications Protocol (CoAP), Message Queue Telemetry Transport protocol (MQTT), 6LowPAN protocol, LoRaWAN protocol	**SDG 9 –** Industry, Innovation, and Infrastructure **SDG 12** – Responsible Consumption and Production **SDG 17 –** Partnerships for the Goals	Evaluating communication protocols helps in deploying scalable, interoperable systems across sectors. This supports innovative infrastructure. (SDG 9) Lightweight protocols enable energy-efficient communication, reducing resource consumption in IoT devices. This optimized resource use in innovation-driven projects. (SDG 9) Lightweight protocols enable energy-efficient communication, reducing resource consumption in IoT devices. This aligns with sustainable production patterns. (SDG 12) Scalable, interoperable systems across sectors supports international collaboration for sustainable development through interconnected. (SDG 17)
Unit III Sensors, Actuators and Development Boards	temperature sensor, humidity and temperature sensor, light sensor, touch sensor, smoke detector, rain detector, ultrasonic sensor, soil	**SDG 3 –** Good Health and Well-being **SDG 4 –** Quality Education **SDG 6 –** Clean Water and	Sensors and actuators are critical in health monitoring and contributes to improved health. (SDG 3) Hands-on skills with development boards promote technical education and

	moisture sensor, RFID, Actuators: Solenoid valve, DC motor, stepper motor, Relay, Development Boards: Arduino board, Node MCU, Raspberry pi	Sanitation **SDG 8 –** Decent Work and Economic Growth **SDG 13 –** Climate Action	empower students for careers in emerging technology sectors, thereby enhancing educational opportunities. (SDG 4) Sensors and actuators are critical in water quality tracking and contributes to improved sanitation. (SDG 6) Hands-on skills with development boards promote technical education and empower students for careers in emerging technology sectors, thereby enhancing economic opportunities. (SDG 8) Sensors and actuators are critical in environmental sensing and energy efficiency systems. Their assessment contributes to improved climate-resilient technology. (SDG 13)
Unit IV IoT web Services and Applications	Cloud platforms for IOT, virtualization concepts and cloud architecture, cloud computing, benefits, cloud services - SaaS, PaaS, IaaS, cloud providers & offerings, IoT Applications: Smart Home, Smart City, Precision Agriculture, health care	**SDG 7 –** Affordable and Clean Energy **SDG 11 –** Sustainable Cities and Communities **SDG 13 –** Climate Action	Understanding cloud integration with IoT allows for efficient data handling, real-time analytics, and deployment of smart solutions in energy. (SDG 7) Understanding cloud integration with IoT allows for efficient data handling, real-time analytics, and deployment of smart solutions in transportation management. (SDG 11) Understanding cloud integration with IoT allows for efficient data handling, real-time analytics, and deployment of smart solutions in environmental management. (SDG 13)

Course Outcome (CO) – SDG Mapping

Course Outcome	Mapped SDG(s)
CO1 – Illustrate IoT framework and architecture of IoT/M2M	SDG 9, SDG 11
CO2 – Assess the wired and wireless communication protocols for IoT/M2M applications	SDG 9, SDG 17
CO3 – Summarize light weight IoT/M2M protocols and addressing schemes	SDG 9, SDG 12
CO4 – Assess the sensor and actuator technology for IoT/M2M applications	SDG 3, SDG 6, SDG 13
CO5 – Demonstrate the development boards for IoT/M2M applications	SDG 4, SDG 8
CO6 – Summarize the cloud architecture and case studies of IoT applications	SDG 7, SDG 11, SDG 13

Justifications for each SDG highlighted

SDG 3 – Good Health and Well-being

- Sensors and actuators are critical in health monitoring and contributes to improved health.

SDG 4 – Quality Education

- Hands-on skills with development boards promote technical education and empower students for careers in emerging technology sectors, thereby enhancing educational opportunities.

SDG 6 – Clean Water and Sanitation

- Sensors and actuators are critical in water quality tracking and contributes to improved sanitation.

SDG 7 – Affordable and Clean Energy

- Understanding cloud integration with IoT allows for efficient data handling, real-time analytics, and deployment of smart solutions in energy.

SDG 8 – Decent Work and Economic Growth

- Hands-on skills with development boards promote technical education and empower students for careers in emerging technology sectors, thereby enhancing economic opportunities.

SDG 9 – Industry, Innovation, and Infrastructure

- Understanding IoT frameworks and architectures is foundational for building smart, efficient systems.
- Evaluating communication protocols helps in deploying scalable, interoperable systems across sectors. This supports innovative infrastructure.

- Lightweight protocols enable energy-efficient communication, reducing resource consumption in IoT devices. This optimized resource use in innovation-driven projects.

SDG 11 – Sustainable Cities and Communities

- Smart systems are vital in modern infrastructure, smart cities, and industrial innovation, contributing to sustainable urbanization and smart governance.
- Understanding cloud integration with IoT allows for efficient data handling, real-time analytics, and deployment of smart solutions in transportation management.

SDG 12 – Responsible Consumption and Production

- Lightweight protocols enable energy-efficient communication, reducing resource consumption in IoT devices. This aligns with sustainable production patterns.

SDG 13 – Climate Action

- Sensors and actuators are critical in environmental sensing and energy efficiency systems. Their assessment contributes to improved climate-resilient technology.
- Understanding cloud integration with IoT allows for efficient data handling, real-time analytics, and deployment of smart solutions in environmental management.

SDG 17 – Partnerships for the Goals

- Scalable, interoperable systems across sectors supports international collaboration for sustainable development through interconnected

SDG Mapping for Logic Circuit Design Lab

Course Outcome	Mapped SDG(s)	Justification
CO1 – Demonstrate the functionality of Combinational logic ICs	SDG 9 – Industry, Innovation and Infrastructure	Combinational ICs are foundational components in modern electronic systems, supporting innovation and reliable infrastructure across industries.
CO2 – Design the Boolean functions logic using logic gates	SDG 4 – Quality Education SDG 9 – Industry, Innovation and Infrastructure	Developing Boolean logic skills strengthens analytical abilities, fostering quality education and capabilities essential for advanced technology sectors.
CO3 – Implement the combinational logic using logic gates	SDG 9 – Industry, Innovation and Infrastructure	Implementing combinational circuits builds competence to develop efficient digital systems for automation, computing, and communication.
CO4 – Implement the flip-flops using logic gates	SDG 9 – Industry, Innovation and Infrastructure	Flip-flops are critical to memory and sequential systems, essential for processors, embedded controllers, and industrial electronics.
CO5 – Design the shift registers	SDG 9 – Industry, Innovation and Infrastructure SDG 11 – Sustainable Cities and Communities	Shift registers enable efficient data handling and storage, supporting smart devices and intelligent infrastructure in sustainable cities.
CO6 – Design the counters	SDG 9 – Industry, Innovation and Infrastructure SDG 13 – Climate Action	Counters are core to timing and control applications; optimized designs contribute to energy-efficient and sustainable electronic systems.

Justification Highlights by SDG

SDG 4: Quality Education

- Strengthens learners’ understanding of foundational digital electronics concepts, empowering them with practical skills for careers in technology.

SDG 9: Industry, Innovation, and Infrastructure

- All outcomes develop capabilities to design and maintain robust, innovative digital systems crucial for industrial growth and infrastructure development.

SDG 11: Sustainable Cities and Communities

- Shift registers and efficient circuit designs contribute to smart devices, energy management, and intelligent urban systems.

SDG 13: Climate Action

- Low-power and optimized counter designs reduce energy use and carbon footprint of electronic products.

Course Outcome	Mapped SDG(s)
1. Demonstrate the functionality of Combinational logic ICs	SDG 9
2. Design the Boolean functions logic using logic gates	SDG4, SDG9
3. Implement the combinational logic using logic gates	SDG 9
4. Implement the flip-flops using logic gate	SDG 9
5. Design the shift registers	SDG 9, SDG11
6. Design the counters	SDG9, SDG13

Detailed SDG Mapping for Linear Control Systems

Unit-wise SDG Mapping with Topics

Unit	Topic	Relevant SDG(s)	Justification
Unit I	Open Loop and Closed Loop Control Systems	SDG 9	Facilitates industrial automation and smart systems.
Unit I	Modeling of Mechanical Systems	SDG 9	Enables design of robotic systems and smart manufacturing.
Unit I	Block Diagram Reduction Technique	SDG 9	Improves efficiency in complex industrial system design.
Unit I	Feedback Characteristics and Effects	SDG 9	Enhances control and resilience in industrial processes.
Unit II	Time Response of First and Second Order Systems	SDG 9	Critical for industrial process optimization and control.
Unit II	Routh-Hurwitz Stability Criterion	SDG 9	Ensures safe and stable operation of critical systems.
Unit II	Root Locus Concept and Analysis	SDG 9	Vital for control design in transport and energy systems.
Unit II	Effect of Poles and Zeros on Root Locus	SDG 9	Aids in tuning and optimization of system performance.
Unit III	Frequency Response Characteristics	SDG 9	Optimizes industrial and communication system designs.
Unit III	Bode Plot and Stability Analysis	SDG 9, SDG 7	Improves efficiency of renewable energy and control systems.
Unit III	PI, PD, PID Controllers	SDG 9, SDG 7	Essential for energy management and smart grid applications.
Unit III	Lag, Lead, and Lead-Lag Compensators	SDG 9	Enhance performance in industrial automation.
Unit IV	State Space	SDG 9	Enables modern

	Modeling of Physical Systems		control systems in aerospace and transport.
Unit IV	Solution of State Equations	SDG 9	Improves performance of real-time control systems.
Unit IV	Controllability and Observability	SDG 9	Ensures reliability in safety-critical systems.
Unit IV	Eigen Vectors and Diagonalization	SDG 9	Facilitates efficient design of advanced control applications.

Justification Highlights by SDG

1. SDG 7: Affordable and Clean Energy
- Frequency domain controllers (PI, PID, Lead-Lag compensators) are vital in optimizing renewable energy systems like solar inverters and wind turbine control.

2. SDG 9: Industry, Innovation, and Infrastructure
- Control system theory underpins the design of industrial automation, railway control, telemedicine robotics, and smart city infrastructure.

Course Outcome	Mapped SDG(s)
CO1- Identify openloop and closed loop control systems and formulate the mathematical model	SDG 9
CO2- Interpret block diagram representation and signal flowgraph of control system	SDG 9
CO3- Demonstrate time response of system, Routh-Hurwitz , and rootlocus stability criterion	SDG 9
C)4- Illustrate the stability of a system using frequency domain techniques.	SDG 9, SDG 7
CO-5 Design different compensators and controllers in time/frequency domain.	SDG 9, SDG 7
CO-6 Outline the state space modeling of physical systems	SDG 9

<u>SDG Mapping for Logic Circuit Design</u>

Unit	Topic	Relevant SDG(s)	Justification
Unit I Digital Logic Elements	Applications of Gates. Error Detection using parity bit, Error Detection and Correction using Hamming code.	**SDG 4** – Quality Education **SDG 9** – Industry, Innovation, and Infrastructure	Understanding these helps build robust digital systems, promoting technological advancement. (SDG 4) Error detection and correction are foundational in reliable communication systems, computing, and critical infrastructure. (SDG 9)
Unit II Combinational Logic Circuits	Minimization of logic functions using Karnaugh Map and Quine-McClusky method, Implementation of Comparators, Ripple carry adder, carry look ahead adder, Encoder, Priority encoder, Decoder, Multiplexer, De-Multiplexer, Code converters,	**SDG 4 –** Quality Education **SDG 9 –** Industry, Innovation, and Infrastructure **SDG 12 –** Responsible Consumption and Production	Simplifying logic contributes to the design of efficient hardware, reducing power and material consumption in electronics. (SDG 4) Equips students with optimization skills necessary for industrial innovation. (SDG 9) Hands-on circuit implementation fosters innovation and practical engineering skills. (SDG 9) Optimized use of gates can lead to low-power, efficient circuits—supporting sustainable technology development. (SDG 12)
Unit III PLDs and Flip Flops	Programmable logic devices, Sequential logic circuits – flip flops	**SDG 4 –** Quality Education **SDG 8 –** Decent Work and Economic Growth **SDG 9 –** Industry, Innovation, and Infrastructure	Sequential logic is vital for designing memory units, processors, and controllers. (SDG 4) Design skills promote job readiness in tech sectors and contribute to economic growth through innovation. (SDG 8) PLDs are integral to modern electronics and embedded systems. (SDG 9) Analysis and understanding of these systems support development of smarter digital technologies. (SDG 9)
Unit IV Sequential	Registers Asynchronous &	**SDG 4 –** Quality Education	Sequential logic is vital for designing memory units,

Logic Circuits	Synchronous counters, Mealy and Moore state machines, Minimization of completely specified state table using Partition table.	**SDG 9 –** Industry, Innovation, and Infrastructure	processors, and controllers. (SDG 4) Understanding state machines improves modeling of real-time systems such as traffic signals, elevators, etc. (SDG 4) Analysis and understanding of these systems support development of smarter digital technologies. (SDG 9) Promotes precision in system design, boosting innovation. (SDG 9)

<u>Course Outcome (CO) – SDG Mapping</u>

Course Outcome	Mapped SDG(s)
CO1 – Illustrate the applications of Gates and Error Detection and Correction.	SDG 4, SDG 9
CO2 – Identify a suitable tool (K-maps, Tabular etc.) to minimize Boolean expressions.	SDG 4, SDG 9
CO3 – Implement combinational circuits using AOI and Universal logic gates.	SDG 9, SDG 12
CO4 – Design combinational logic circuits using PLDs.	SDG 8, SDG 9
CO5 – Analyse sequential logic circuits	SDG 4, SDG 9
CO6 – Differentiate Mealy and Moore machines.	SDG 4, SDG 9

Justifications for each SDG highlighted

SDG 4 – Quality Education

- Understanding application of gates helps engineers to build robust digital systems, promoting technological advancement.
- Simplifying logic contributes to the design of efficient hardware, reducing power and material consumption in electronics.
- Sequential logic understanding is vital for designing memory units, processors, and controllers.
- Understanding state machines improves modeling of real-time systems such as traffic signals, elevators, etc.

SDG 8 – Decent Work and Economic Growth

- Design skills promote job readiness in tech sectors and contribute to economic growth through innovation.

SDG 9 – Industry, Innovation, and Infrastructure

- Error detection and correction are foundational in reliable communication systems, computing, and critical infrastructure.
- Minimization of logic circuit equips students with optimization skills necessary for industrial innovation.
- Hands-on circuit implementation fosters innovation and practical engineering skills.
- Analysis and understanding of PLDs support development of smarter digital technologies.
- Analysis and understanding of sequential systems support development of smarter digital technologies.
- State machines design promotes precision in system design, boosting innovation.

SDG 12 – Responsible Consumption and Production

Optimized use of gates can lead to low-power, efficient circuits—supporting sustainable technology development.

<u>**SDG Mapping for Python Programming (23EC302)**</u>

Unit-wise SDG Mapping

Unit	Topic	Relevant SDG(s)	Justification
Unit I	Python Basics, Control Structures, Data Types	**SDG 4** – Quality Education **SDG 9** – Industry, Innovation, and Infrastructure	Introduces students to foundational programming concepts essential in the digital age (SDG 4). Skills are core to software development, enabling future innovation and infrastructure design (SDG 9).
Unit II	Data Structures: Lists, Tuples, Sets, Dictionaries; Functional Programming (map, lambda, etc.)	**SDG 4** – Quality Education **SDG 9** – Industry, Innovation, and Infrastructure	Enables understanding and application of structured data manipulation and functional paradigms, forming the backbone of efficient software systems (SDG 4, SDG 9).
Unit III	Functions, Modules, File Handling, Searching & Sorting	**SDG 4** – Quality Education **SDG 8** – Decent Work and Economic Growth **SDG 9** – Industry, Innovation, and	Strengthens logical reasoning and problem-solving skills needed for real-world applications. These skills

		Infrastructure	promote employability in the digital workforce (SDG 8).
Unit IV	NumPy and Pandas	**SDG 4 –** Quality Education **SDG 9 –** Industry, Innovation, and Infrastructure **SDG 12 –** Responsible Consumption and Production	Introduces tools used in data science and analytics. Encourages efficient computation and handling of large datasets (SDG 9). Promotes data-driven sustainable decisions (SDG 12).

Course Outcome (CO) – SDG Mapping

Course Outcome	Mapped SDG(s)
CO1 – Illustrate the fundamentals of Python with syntax and semantics.	SDG 4, SDG 9
CO2 – Use the concepts of conditional and control flow statements.	SDG 4
CO3 – Demonstrate the concepts of strings, dictionaries, sets, list and tuples.	SDG 4, SDG 9
CO4 – Demonstrate the concepts of Functions and Modules.	SDG 4, SDG 8
CO5 – Use the concepts of files, searching and sorting mechanisms.	SDG 4, SDG 9
CO6 – Demonstrate NumPy and Pandas.	SDG 4, SDG 9, SDG 12

Justification Summary for Mapped SDGs

SDG 4 – Quality Education

- Enhances coding literacy, critical thinking, and problem-solving in computational environments, key for 21st-century skills.

SDG 8 – Decent Work and Economic Growth

- Equips learners with industry-relevant programming and data analysis skills, fostering employability in the tech sector.

SDG 9 – Industry, Innovation, and Infrastructure

- Programming enables digital infrastructure and innovation in AI, software, automation, and smart systems.

SDG 12 – Responsible Consumption and Production

- Promotes efficient resource use via data-driven decision making, and optimizations using Python tools like Pandas and NumPy.

SDG Mapping for Real Time Operating Systems

SDG Mapping for RTOS

Unit	Topic	Relevant SDG(s)	Justification
Unit I Real Time System	Real time system concepts, types, timing constraints, classification and modelling, safety and reliability.	SDG 9 – Industry, Innovation and Infrastructure	Understanding real-time system design supports innovative, dependable technologies in industries and infrastructure.
Unit II Real Time Operating System	RTOS vs GPOS, task synchronization, mutual exclusion, embedded C programming.	SDG 9 – Industry, Innovation and Infrastructure SDG 4 – Quality Education	RTOS forms core of embedded systems in critical industries and hands-on coding promotes quality education in engineering.
Unit III Real Time Scheduling Approaches	Non-preemptive and preemptive scheduling, hybrid schedulers, RMA.	SDG 9 – Industry, Innovation and Infrastructure	Efficient scheduling is key to innovation in embedded and automation industries.
Unit IV Commercial RTOS & Real Time Communication	POSIX, μC/OS-II, VxWorks, RT communication, LAN and packet networks.	SDG 9 – Industry, Innovation and Infrastructure SDG 11 – Sustainable Cities and Communities	RT communication supports smart infrastructure, traffic systems, and city-wide automation.

Justification Highlights by SDG

1. SDG 4: Quality Education
RTOS concepts and embedded programming enhance technical competency and hands-on learning among students.

2. SDG 9: Industry, Innovation and Infrastructure
Entire course promotes development of robust embedded systems for industrial and infrastructure applications.

3. SDG 11: Sustainable Cities and Communities
RTOS and real-time communication are essential in smart traffic control, emergency response, and smart city frameworks.

Course Outcome

Course Outcome	Mapped SDG(s)
CO1 – Summarize the real time systems and its characteristics	SDG 9
CO2 – Exemplify classification and modelling of time constraints	SDG 9
CO3 – Assess the Task synchronisation in Real Time Operating System	SDG 4, SDG 9
CO4 – Illustrate real time communication and its applications	SDG 9, SDG 11
CO5 – Compare various Real Time Scheduling Approaches	SDG 9
CO6 – Outline the suitable real time operating systems for commercial applications	SDG 9, SDG 11

SDG Mapping for Signals and Systems

Unit-wise SDG Mapping

Unit	Topic	Relevant SDG(s)	Justification
Unit I	Signal Analysis, Orthogonal signal space, Signal approximation, Biomedical signals (EEG, ECG)	SDG 3 – Good Health and Well-being, SDG 9 – Industry, Innovation and Infrastructure	Understanding and analyzing biomedical signals like EEG and ECG helps in health monitoring systems. Signal analysis also forms the foundation of digital communication and smart sensing technologies.
Unit II	Fourier Series, Fourier Transform, Laplace Transform	SDG 9 – Industry, Innovation and Infrastructure	These mathematical tools are essential in developing efficient communication, signal processing, and automation systems.
Unit III	LTI Systems, Convolution, Correlation, Power/Energy spectrum	SDG 9 – Industry, Innovation and Infrastructure	LTI systems are foundational to modern electronics, filters, and communication systems used in smart infrastructure and automation.
Unit IV	Sampling Theory, Aliasing, Signal Reconstruction	SDG 9 – Industry, Innovation and Infrastructure, SDG 4 – Quality Education	Sampling and reconstruction are key to digitizing analog data—essential in IoT, signal acquisition systems, and digital education tools.

Course Outcome – SDG Mapping

Course Outcome	Mapped SDG(s)	Justification
CO1 – Interpret various types of signals and systems and their operations	SDG 9	Foundation for digital signal processing and communication systems, supporting innovation and infrastructure.

CO2 – Explain signal approximation using Fourier series	SDG 9	Enables efficient signal representation, crucial for communication and automation systems.
CO3 – Execute Fourier and Laplace transforms of continuous signals	SDG 9	Integral to signal analysis in engineering applications such as filtering, modulation, and control systems.
CO4 – Summarize characteristics of LTI system and its properties	SDG 9	LTI systems underpin system modeling in infrastructure, telecommunication, and electronics.
CO5 – Compute LTI system response using convolution, correlation	SDG 9, SDG 3	Correlation methods are vital in detecting health-related signals and for signal processing in smart healthcare systems.
CO6 – Interpret sampling process and its effects	SDG 9, SDG 4	Fundamental for digitization and signal-based educational simulations and learning platforms.

SDG Mapping for UHF and EHF Communication Systems

Unit	Topic	Relevant SDG(s)	Justification
Unit I Satellite and Subsystems	Spectrum characteristics, spectrum ranges, Look Angle determination and satellite Applications	SDG 9 – Industry, Innovation and Infrastructure SDG 13- Climate Action	• Satellite subsystem enables connectivity and communication for remote or underserved areas. • Satellites monitor climate-related phenomena, such as weather patterns and sea-level rise.
Unit II Satellite Link Design	Link margin, Transmitter Power, Antenna Gain	SDG 9 – Industry, Innovation and Infrastructure SDG 11 – Sustainable Cities and Communities	• Satellite link budget is crucial for designing and operating reliable communication systems, which support industry and infrastructure development. • Satellite communication supports disaster response and management, contributing to sustainable cities and communities.
Unit III RADAR and its Applications	Operations of various RADAR and its characteristics	SDG 13- Climate Action SDG 15: Life on Land	• RADAR technology supports climate action by monitoring weather patterns and providing critical information for climate forecasting. • RADAR technology monitors environmental changes, supporting conservation efforts and sustainable land use.
Unit IV Tracking RADAR	Tracking in Range, Acquisition, Scanning Patterns, Radomes	SDG 9 – Industry, Innovation and Infrastructure SDG 13- Climate Action	• Tracking RADAR systems enhance aviation and maritime safety by monitoring air and sea traffic. • Tracking RADAR systems monitor weather patterns, enabling better climate forecasting and warning systems.

Justification Highlights by SDG

1. SDG 9: Industry, Innovation, and Infrastructure

The entire course fosters innovative designs for telecommunications, space tech, radar systems, and wireless communication—key enablers of digital infrastructure.

2. SDG 11: Sustainable Cities and Communities

Smart antennas are vital in developing smart city networks, traffic control systems, and urban sensing platforms.

3. SDG 13- Climate Action

Satellites are instrumental in monitoring climate change effects, such as rising sea levels, melting polar ice, and changes in global weather patterns. They provide critical data for understanding and mitigating climate change impacts, making them essential for achieving this goal.

4. SDG 15: Life on Land

Tracking RADAR systems can monitor environmental changes, such as land use and wildlife habitats.

Course Outcome	Mapped SDG(s)
CO1 – Interpret the various subsystems and their parameters	SDG 9, SDG 13
CO2 – Asses various multiple access techniques and spread spectrum techniques	SDG 9, SDG 11
CO3 – Demonstrate the concepts of Link Design	SDG 9, SDG 11
CO4 – Explain RADAR parameters and applications	SDG 13
CO5 – Demonstrate the operation of CW and MTI RADARs	SDG 15
CO6 – Differentiate the tracking techniques for RADARs	SDG 9, SDG 13

SDG Mapping for VLSI Design Course

Unit	Topic	Relevant SDG(s)	Justification
Unit I	Introduction and basic electrical properties of MOS circuits	**SDG 9 –** Industry, Innovation, and Infrastructure	Provides foundational knowledge for chip design, supporting the semiconductor industry and digital infrastructure.
Unit II	Basics of VLSI	**SDG 9**	Trains students in designing and analyzing combinational logic, essential for digital system innovation.
Unit III	Basic Digital and Analog Circuits	**DG 4 –** Quality Education**, SDG 9**	Involves memory and subsystem design used in embedded systems, smart devices, and urban automation.
Unit IV	VLSI Implementation Strategies and Testing	**SDG 9, SDG 7 –** Affordable and Clean Energy *(Indirectly)*	Ensures quality and reliability in ICs used for clean energy systems, reducing waste and improving testing infrastructure.

Course Outcome (CO) – SDG Mapping

CO No.	Course Outcome	Mapped SDG(s)	Justification
CO1	Explain the basic MOSFET circuits operation and MOS fabrication Process	**SDG 9**	Supports development of energy-efficient digital circuits used in high-performance systems.
CO2	Implement the layout diagrams for CMOS circuits	**SDG 9**	Strengthens practical knowledge for digital VLSI design, relevant to industry automation.
CO3	Assess the effects of parasitics and Scaling of MOS circuits	**SDG 4, SDG 9**	Enhances educational quality through design skills and industry-standard CAD tools.
CO4	Interpret the operation of basic analog and digital MOSFET circuits	**SDG 4**	Enables development of systems used in smart electronics for urban infrastructure.
CO5	Implement the Digital and Analog circuits with Full-custom and Semi-custom design flows.	**SDG 9**, **SDG 11**	Supports energy-efficient and fault-tolerant chip design applicable in clean energy and IoT.
CO6	Interpret the VLSI implementation flows and the basics of VLSI testing	**SDG 9, SDG 7**	Strengthens industry-relevant skills for semiconductor innovation.

Justifications for each SDG highlighted

SDG 4 – Quality Education

- Builds essential digital and circuit design skills through CAD and VLSI tools.
- Encourages deep technical understanding and hands-on learning in electronics.
- Supports project-based and outcome-driven learning pedagogy.

SDG 7 – Affordable and Clean Energy *(Indirect Link)*

- Testing and low-power design techniques are applicable to smart meters and renewable energy systems.
- Promotes efficient design of chips used in energy-conscious embedded systems.

SDG 9 – Industry, Innovation, and Infrastructure

- Directly prepares students for roles in semiconductor and electronics design industries.
- Covers VLSI design flow, DFT, and layout—all essential for industrial chip fabrication and innovation.
- Promotes infrastructure for digital transformation through ICs.

SDG 11 – Sustainable Cities and Communities

- Knowledge of subsystems and memory circuits applies to embedded devices used in urban sensing, smart grids, and public automation.
- Supports innovation in smart city applications through reliable digital electronics.

SDG Mapping for RVSP (Random Variables and Stochastic Processes)

Unit-wise SDG Mapping

Unit	Topic	Relevant SDG(s)	Justification
Unit I	Probability Theory	SDG 4 – Quality Education	Builds foundational understanding of uncertainty, essential for AI, data science, and engineering fields.
Unit II	The Random Variable	SDG 9 – Industry, Innovation and Infrastructure	Supports development of robust systems through understanding of noise, variability, and randomness in engineering models.
Unit III	Multiple Random Variables	SDG 9 – Industry, Innovation and Infrastructure	Critical for signal processing, wireless communication, and reliability analysis in infrastructure.
Unit IV	Random Processes	SDG 9 – Industry, Innovation and Infrastructure SDG 11 – Sustainable Cities and Communities	Random processes are used in traffic modeling, smart grids, environmental monitoring, and communications.

Justification Highlights by SDG

1. SDG 4: Quality Education
Probability theory underpins critical thinking and problem solving in STEM education, empowering students to tackle uncertainty.

2. SDG 9: Industry, Innovation, and Infrastructure
Understanding random variables and processes is essential for designing resilient systems in communication, manufacturing, and robotics.

3. SDG 11: Sustainable Cities and Communities
Stochastic modeling supports smart city systems such as traffic forecasting, energy distribution, and environmental sensing.

Course Outcomes to SDG Mapping

Course Outcome	Mapped SDG(s)
CO1 – Exemplify the probability theory concepts and Bayes theorem	SDG 4
CO2 – Illustrate the distribution and density functions of random variable	SDG 9
CO3 – Compute the moments of random variable	SDG 9
CO4 – Represent the statistical properties of multiple random variables	SDG 9
CO5 – Compute the joint moments and their functions	SDG 9
CO6 – Outline the statistical characteristics of random processes	SDG 9, SDG 11

SDG Mapping for Linear Integrated Circuits

Unit-wise SDG Mapping

Unit	Topic	Relevant SDG(s)	Justification
Unit I	Differential amplifiers, current mirrors, IC classification, Op-Amp characteristics, frequency response	SDG 9 – Industry, Innovation and Infrastructure	Forms the core of analog IC design, essential for modern electronics and instrumentation systems.
Unit II	OP-AMP applications: amplifiers, oscillators, waveform generators, precision rectifiers	SDG 9 – Industry, Innovation and Infrastructure	Enables design of precision analog systems used in industrial, biomedical, and control systems.
Unit III	Analog filters, 555 Timer, PLL, AM/FM/FSK demodulation	SDG 9 – Industry, Innovation and Infrastructure	Supports signal processing, communication systems, and analog control systems in technology infrastructure.
Unit IV	DAC, ADC, IC Regulators, Logic families	SDG 9 – Industry, Innovation and Infrastructure	Fundamental for interfacing analog and digital domains in embedded, automation, and measurement systems.

Course Outcome – SDG Mapping

Course Outcome	Mapped SDG(s)	Justification
CO1 – Illustrate the characteristics and internal structure of Operational amplifier	SDG 9	Helps understand analog circuit design for efficient signal processing applications.
CO2 – Classify various configurations of differential amplifiers	SDG 9	Essential for designing accurate analog front-ends used in instrumentation and communication systems.
CO3 – Differentiate linear and non-linear applications of operational amplifier	SDG 9	Provides foundation for analog signal conditioning and automation circuits.
CO4 – Design various types of analog filters	SDG 9	Important for filtering unwanted noise in analog signals and enhancing signal quality.
CO5 – Outline the operation and applications of IC 555 timer and PLL	SDG 9	Vital for timing control and synchronization in embedded and communication systems.
CO6 – Compute the working of various types of ADCs and DACs	SDG 9	Key for signal conversion and interfacing in digital control and measurement systems.

SDG Mapping for Project Work

COs	Relevant SDG(s)	Justification
1. Identify a contemporary engineering application to serve the society at large	SDG 3 (Good Health and Well-being), SDG 7 (Affordable & Clean Energy), SDG 9 (Industry, Innovation, and Infrastructure), SDG 11 (Sustainable Cities and Communities)	Depending on the problem selected, it encourages students to target engineering applications that solve real-world problems in infrastructure, cities, energy efficiency and community health.
2. Use engineering concepts and computational tools to get the desired solution	SDG 4 (Quality Education), SDG 9 (Industry, Innovation, and Infrastructure)	Builds technical skills and innovation capacity through computational tools and engineering principles.
3. Justify the assembled/ fabricated/developed products intended	SDG 12 (Responsible Consumption and Production), SDG 9 (Industry, Innovation, and Infrastructure)	Promotes sustainability in design, materials selection, and responsible resource use.
4. Organize documents and present the project report articulating the applications of the concepts and ideas coherently	SDG 4 (Quality Education), SDG 17 (Partnerships for the Goals)	Develops communication skills and knowledge sharing, enabling potential collaboration and dissemination.
5. Demonstrate ethical and professional attributes during the project implementation	SDG 16 (Peace, Justice, and Strong Institutions), SDG 5 (Gender Equality)	Emphasizes ethics, fairness, inclusivity, and accountability in engineering practice.
6. Execute the project in a collaborative environment	SDG 17 (Partnerships for the Goals), SDG 8 (Decent Work and Economic Growth) SDG 10 (Reduced Inequalities)	Encourages teamwork, collaborative problem-solving, interdisciplinary and inclusive work culture, and professional growth.

SDG No.	**SDG Title**	**Relevance to ECE Projects**
3	Good Health & Well-Being	Biomedical devices, wearable health monitors, IoT-based patient monitoring
4	Quality Education	Projects on Low-cost electronics kits, virtual labs, remote learning platforms

SDG No.	SDG Title	Relevance to ECE Projects
7	Affordable & Clean Energy	Solar-powered communication devices, energy-efficient embedded systemsrelated projects
8	Decent Work & Economic Growth	Industrial IoT solutions, automation systems, process monitoring tools
9	Industry, Innovation & Infrastructure	VLSI design, advanced communication protocols and prototypes, embedded system innovations
10	Reduced Inequalities	Low-cost assistive technologies, community-based communication networks
11	Sustainable Cities & Communities	Smart city IoT networks, environmental pollution monitoring
12	Responsible Consumption & Production	Eco-friendly PCB design, electronic waste reuse and refurbishment
16	Peace, Justice & Strong Institutions	Secure IoT communication, encryption-based data protection related projects
17	Partnerships for the Goals	Academia–industry partnerships, hackathons, collaborative research projects