



**Sharad Institute of Technology College of Engineering**  
(An Autonomous Institute)  
Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

**Department:** Electronics and Computer Engineering **Rev:** Course Structure/01/NEP/2023-24

**Class:** Final Year B. Tech

**Semester:** VII

| Course Code  | Course Type | Course                                   | Teaching Scheme |          |           |            | Evaluation Scheme |            |            |            |            | Credits   |
|--------------|-------------|------------------------------------------|-----------------|----------|-----------|------------|-------------------|------------|------------|------------|------------|-----------|
|              |             |                                          | L               | T        | P         | Total Hrs. | CA1               | CA2        | MSE        | ESE        | Total      |           |
| 23EC4701     | PCC         | Very large-scale Integration Design      | 3               | -        | -         | 3          | 10                | 10         | 30         | 50         | 100        | 3         |
| 23EC4702     | PCC         | Computer Network and Security            | 3               | -        | -         | 3          | 10                | 10         | 30         | 50         | 100        | 3         |
| 23EC4703     | PEC         | Program Elective Course - III            | 3               | -        | -         | 3          | 10                | 10         | 30         | 50         | 100        | 3         |
| 23EC4704     | PEC         | Program Elective Course - IV             | 3               | -        | -         | 3          | 10                | 10         | 30         | 50         | 100        | 3         |
| 23ECMDXX     | MDM         | Multidisciplinary Minor-V                | 3               | -        | -         | 3          | 10                | 10         | 30         | 50         | 100        | 3         |
| 23EC4705     | PCC         | Very large-scale Integration Laboratory  | -               | -        | 2         | 2          | 15                | 15         | -          | 20         | 50         | 1         |
| 23EC4706     | PCC         | Computer Network and Security Laboratory | -               | -        | 2         | 2          | 15                | 15         | -          | 20         | 50         | 1         |
| 23EC4707     | RM          | Research Methodology                     | 3               | -        | -         | 3          | 10                | 10         | 30         | 50         | 100        | 3         |
| 23EC4708     | RM          | Seminar                                  | -               | -        | 2         | 2          | 15                | 15         |            | 20         | 50         | 1         |
| 23EC4709     | PROJ        | Capstone Project - II                    | -               | -        | 4         | 4          | 25                | 25         |            | -          | 50         | 2         |
| 23EC4710     | VEC         | Values and Ethics                        | 1               | -        | -         | 1          | 25                | 25         |            | -          | 50         | Audit     |
| <b>Total</b> |             |                                          | <b>19</b>       | <b>-</b> | <b>10</b> | <b>29</b>  | <b>155</b>        | <b>155</b> | <b>180</b> | <b>360</b> | <b>850</b> | <b>23</b> |

**Multidisciplinary Minor -V**

| Biomedical Engineering<br>(Basket A)   | Data Science<br>(Basket B)                | Industrial Automation<br>(Basket C)          |
|----------------------------------------|-------------------------------------------|----------------------------------------------|
| Medical Image Processing<br>(23ECMDA5) | Advanced Data Visualization<br>(23ECMDB5) | Industrial Automation and Control (23ECMDC5) |

**Program Elective Course -III**

|                                     |
|-------------------------------------|
| Digital Image Processing(23EC4703A) |
| Cloud Computing(23EC4703B)          |
| Satellite Communication(23EC4703C)  |

**Program Elective Course -IV**

|                                       |
|---------------------------------------|
| Real Time Operating System(23EC4704A) |
| Microwave Engineering(23EC4704B)      |
| Block Chain Management(23EC4704C)     |



*verified*  
*S. V. Kulkarni*

f. *K. Jagtap* Page 1 | 31  
**Head of the Department**  
**Electronics & Computer Engineering**  
**SHARAD INSTITUTE OF TECHNOLOGY**  
**COLLEGE OF ENGINEERING**  
**Yadrav (Ichalkaranji) Dist. Kolhapur**



**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**

Yadav (Ichalkaranji)-416121, Dist. – Kolhapur

**Very Large-Scale Integration Design**

|          |     |                                     |       |           |
|----------|-----|-------------------------------------|-------|-----------|
| 23EC4701 | PCC | Very Large-Scale Integration Design | 3-0-0 | 3-Credits |
|----------|-----|-------------------------------------|-------|-----------|

| Teaching Scheme:    | Evaluation Scheme:                                                                          |
|---------------------|---------------------------------------------------------------------------------------------|
| Lectures: 3Hrs/Week | CA-I :10Marks<br>CA-II :10Marks<br>Mid Semester Exam: 30Marks<br>End Semester Exam: 50Marks |

**Pre-requisites:** Fundamentals of Digital circuits

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                                                             |
|-----|-----------------------------------------------------------------------------|
| CO1 | Explain VLSI Design flow, VHDL features, attributes, operators.             |
| CO2 | Build combinational logic circuits using VHDL.                              |
| CO3 | Construct sequential circuits like counter, serial adder, sequence detector |
| CO4 | Develop adder, decoder, encoder, mux using Verilog.                         |
| CO5 | Explain basics of MOS transistor theory                                     |
| CO6 | Elaborate basics of PLD architecture, testing and fault-finding methods     |

**Course Contents:**

|                                                                                                                                                                                                                                                                                   |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>Unit 1: Introduction to VHDL</b><br>Need of HDL, VLSI Design flow, Levels of abstraction Features and capabilities of VHDL, Elements of VHDL, data objects, data types, operators, attributes                                                                                  | [6] |
| <b>Unit 2: Combinational logic design using VHDL</b><br>Concurrent statements, Adder, Subtractor, decoder, encoder, tri state buffer, multiplexer, parity generator, parity checker, comparator, barallel shifter                                                                 | [6] |
| <b>Unit 3: FSM Design Using VHDL</b><br>Impediments to synchronous design, clock jitter, skew, gating the clock, asynchronous inputs, meta-stability and synchronizer failure. VHDL implementation of counter, shift register, LFSR, Serial adder. Bus arbiter, sequence detector | [6] |
| <b>Unit 4: Introduction to Verilog</b><br>Basic verilog naming conventions, verilog operators, data types, assignment statements, control statements, behavioral modeling in verilog HDL, combinational logic design using verilog.                                               | [6] |
| <b>Unit 5: MOS Transistor theory</b><br>Physical structure of MOS transistor, MOS transistor under static conditions, Introduction to CMOS inverter and its V-I characteristics.                                                                                                  | [6] |
| <b>Unit 6: PLD Architectures and Testing</b><br>Basic architecture of Xilinx 9500 series CPLD (XC9572), Spartan II FPGA (XC3s400)<br>Testing: Fault models, path sensitizing, random test, design for testability, Built-in self test and Boundary scan.                          | [6] |
| <b>Text Books:</b><br>1. Volnei A. Pedroni, "Circuit Design with VHDL", third edition, MIT press                                                                                                                                                                                  |     |







**Sharad Institute of Technology College of Engineering  
(An Autonomous Institute)**

Yadav (Ichalkaranji)-416121, Dist. – Kolhapur

2. Douglas Perry, "VHDL", Tata MC-Graw Hill
3. Verilog HDL A Guide To Digital Design And Synthesis, Edition: 2 by Samir Palnitkar
4. J. Bhasker, "A VHDL Primer", Prentice Hall PTR, 1999
5. A. AnandKumar, "Fundamentals of Digital Circuits", second edition, PHI

**Reference Books:**

1. Stephen Brown and Zvonko Vranesic "Fundamentals of Digital Logic with VHDL design", Tata- McGraw Hill
2. D. A. Pucknell and K. Eshraghian, "Basic VLSI Design", Prentice Hall India, 3rd Edition, 2003



Head of the Department  
Electronics & Computer Engineering  
SHARAD INSTITUTE OF TECHNOLOGY  
COLLEGE OF ENGINEERING  
Yadav (Ichalkaranji) Dist. Kolhapur



**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**

Yadav (Ichalkaranji)-416121, Dist. – Kolhapur

**Computer Network and Security**

|          |     |                               |       |           |
|----------|-----|-------------------------------|-------|-----------|
| 23EC4702 | PCC | Computer Network and Security | 3-0-0 | 3-Credits |
|----------|-----|-------------------------------|-------|-----------|

| Teaching Scheme:    | Evaluation Scheme:                                                                          |
|---------------------|---------------------------------------------------------------------------------------------|
| Lectures: 3Hrs/Week | CA-I :10Marks<br>CA-II :10Marks<br>Mid Semester Exam: 30Marks<br>End Semester Exam: 50Marks |

**Pre-requisites:** Basic Communication System.

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                                                                           |
|-----|-------------------------------------------------------------------------------------------|
| CO1 | Summarize fundamentals of computer communication network.                                 |
| CO2 | Explain the Data link layer with Multiple access concept.                                 |
| CO3 | Apply the concept of routing technique and IPv6 address in computer Network.              |
| CO4 | Make use of Transport layer concepts and application layer technique in computer Network. |
| CO5 | Simplify various network security techniques used in computer network.                    |

**Course Contents:**

|                                                                                                                                                                                                                                                                                      |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>Unit 1 : Introduction to Local Area Networks</b><br>Data Communication, Networks, OSI Model, TCP/IP Protocol Suit, Wired LAN: Standard Ethernet, Fast Ethernet (100 MBPS), Gigabit Ethernet, 10 Gigabit Ethernet. Wireless LAN: Introduction, IEEE 802.11.                        | [6] |
| <b>Unit 2 : Data link Layer</b><br>Error detection and correction- Types of Errors, detection versus correction, Forward error correction versus retransmission Block coding, Error detection, Error correction, Multiple Access: - Aloha, CSMA, CSMA/CD, CSMA/CA.                   | [6] |
| <b>Unit 3 : Network Layer</b><br>Introduction, Network-Layer Services, Packet Switching, IPv4 Addresses, Network Layer Protocols: Internet Protocol (IP), Routing Algorithms, Next Generation IP:-IPv6 Addressing.                                                                   | [6] |
| <b>Unit 4 : Transport and Application Layer</b><br>Introduction to Transport Layer, Process to Process Delivery, User Datagram Protocol, Transmission Control Protocol, SCTP. Standard Client Server Protocols: World Wide Web, Electronic Mail, DNS.                                | [6] |
| <b>Unit 5 : Network Management and Security</b><br>Network Management: Function of Network management, SNMP. Network Security: Cryptography: Introduction, Types of Cryptography, Symmetric Cryptography:- Traditional Ciphers, Substitution Cipher, Transposition Ciphers.          | [6] |
| <b>Unit 6 : Network Security</b><br>Cryptography:- Asymmetric Cryptography:- RSA, Diffie-Hellman, Man-in-the-Middle Attack, Network Security: Security Services:- Message Confidentiality. Message Integrity, Message Authentication, Security in the Internet: IPSec and Firewalls. | [6] |



Page 4 | 31

*Chakole*

Head of the Department  
Electronics & Computer Engineering  
SHARAD INSTITUTE OF TECHNOLOGY  
COLLEGE OF ENGINEERING  
Yadav (Ichalkaranji) Dist.Kolhapur





**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**

Yadav (Ichalkaranji)-416121, Dist. – Kolhapur

**Text Books:**

1. Behrouz A. Forouzan, "Data Communications and Networking" MacGraw Hill, 5th edition
2. James F. Kurose & W. Rouse, —Computer Networking: A Topdown Approach, 6th Edition, Pearson Education.

**Reference Books:**

1. Andrew S. Tannenbaum, —Computer Networks, Pearson Education, Fourth Edition, 2003
2. Wayne Tomasi, —Introduction to Data Communication and Networking, 1/e, Pearson Education
3. Natalia Olifer, Victor Olifer, —Computer Networks Wiley Student Edition.



  
Head of the Department  
Electronics & Computer Engineering  
SHARAD INSTITUTE OF TECHNOLOGY  
COLLEGE OF ENGINEERING  
Yadav (Ichalkaranji) Dist. Kolhapur



**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**  
Yadav (Ichalkaranji)-416121, Dist. – Kolhapur

**Program Elective Course -III**

**Digital Image Processing**

|           |     |                          |       |           |
|-----------|-----|--------------------------|-------|-----------|
| 23EC4703A | PEC | Digital Image Processing | 3-0-0 | 3-Credits |
|-----------|-----|--------------------------|-------|-----------|

| Teaching Scheme:    | Evaluation Scheme:                                                                          |
|---------------------|---------------------------------------------------------------------------------------------|
| Lectures: 3Hrs/Week | CA-I :10Marks<br>CA-II :10Marks<br>Mid Semester Exam: 30Marks<br>End Semester Exam: 50Marks |

**Pre-requisites:** Introduction to Digital Signal Processing

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                                                                                                |
|-----|----------------------------------------------------------------------------------------------------------------|
| CO1 | Outline fundamental steps involved in Digital Image Processing & Perform operations on color image processing. |
| CO2 | Apply different image transforms for image enhancement                                                         |
| CO3 | Make use of different filtering techniques on an image.                                                        |
| CO4 | Analyze image processing techniques for object segmentation and recognition.                                   |
| CO5 | Explain 2-D data compression techniques for digital images                                                     |
| CO6 | Solve image restoration problems.                                                                              |

**Course Contents:**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                          |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>Unit 1: Digital Image Fundamentals</b><br>Fundamentals steps in DIP, components of image processing system, Elements of visual perception, image sensing and acquisition, Image sampling and quantization, basic relations between pixels, Color fundamentals, color models, Full color image processing, color transformations.                                                                                                                      | [6] |
| <b>Unit 2: Image Transform</b><br>Basic intensity transformation: image negation, Log transformation, power law transformation, Piecewise linear transformation functions, arithmetic and Logic operation, Histogram processing (equalization and matching).                                                                                                                                                                                             | [6] |
| <b>Unit 3: Image filtering</b><br>Fundamentals of spatial filtering, Smoothing in spatial domain, sharpening in spatial domain, Smoothing in frequency domain, Sharpening in frequency domain.                                                                                                                                                                                                                                                           | [6] |
| <b>Unit 4: Image segmentation</b><br><b>Detection of discontinuities:</b> Point detection, line detection, edge detection, Global and adaptive Thresholding, Region based segmentation (region growing, region splitting and merging),<br><b>Morphology:</b> Dilation & erosion, Opening and closing operation, Hit- or –miss transformation<br>Basic morphological algorithms: Boundary extraction, region filling, Thinning and thickening, skeletons. | [6] |
| <b>Unit 5: Image Compression</b>                                                                                                                                                                                                                                                                                                                                                                                                                         | [6] |







**Sharad Institute of Technology College of Engineering  
(An Autonomous Institute)**

Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

|                                                                                                                                                                                                                                                                                                     |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Fundamentals, Coding redundancy, fidelity criteria. Image compression model, lossless predictive coding, Lossy predictive coding, Image compression standards JPEG and JPEG 2000.                                                                                                                   |     |
| <b>Unit 6: Image Restoration</b><br>A model of the Image Degradation / Restoration process, Noise Models, Restoration in the Presence of Noise only-spatial filtering, Minimum Mean square Error (Wiener) filtering, Geometric Mean Filter, Geometric Transformations                               | [6] |
| <b>Text Books:</b><br>1.Digital image processing: Rafael C Gonzalez, Richard E. Woods: Pearson Publication Image<br>2.Iain E. G. Richardson, —H.264 and MPEG<br>3.Digital image processing and Analysis- B. Chanda, D. Datta, majnudar.<br>4.Fundamentals of digital Image Processing- Anil K.Jain. |     |
| <b>Reference Books:</b><br>1.A. K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.<br>2.Pratt William K. "Digital Image Processing", John Wiley & sons<br>3.Digital image processing- S. Jayraman, S Esakkirajan ,Veerakumar:MGH                                      |     |



*Bohale*

Page 7/31  
**Head of the Department**  
**Electronics & Computer Engineering**  
**SHARAD INSTITUTE OF TECHNOLOGY**  
**COLLEGE OF ENGINEERING**  
**Yadrav (Ichalkaranji) Dist.Kolhapur**



**Sharad Institute of Technology College of Engineering**  
(An Autonomous Institute)

Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

**Cloud Computing**

|           |     |                 |       |           |
|-----------|-----|-----------------|-------|-----------|
| 23EC4703B | PEC | Cloud Computing | 3-0-0 | 3-Credits |
|-----------|-----|-----------------|-------|-----------|

| Teaching Scheme:    | Evaluation Scheme:                                                                          |
|---------------------|---------------------------------------------------------------------------------------------|
| Lectures: 3Hrs/Week | CA-I :10Marks<br>CA-II :10Marks<br>Mid Semester Exam: 30Marks<br>End Semester Exam: 50Marks |

**Pre-requisites:** Basics of networking and different Types of cloud.

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                                                |
|-----|----------------------------------------------------------------|
| CO1 | Explain Cloud Services.                                        |
| CO2 | Illustrate the Architecture of cloud computing.                |
| CO3 | Identify cloud services use and its storage.                   |
| CO4 | Make use of cloud Security                                     |
| CO5 | Explain the administration and risk factor of cloud computing. |
| CO6 | Elaborate cloud Adoption services                              |

**Course Contents:**

|                                                                                                                                                                                                                                                                                                                                                               |     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>Unit 1: Introduction to Cloud Computing</b><br>Introduction, Evolution of cloud computing, Components of cloud computing, computing services delivery models, Parallel v/s distributed computing, Cloud Characteristics Virtualization Introduction and benefits, Implementation levels of Virtualization, Virtualization structure, Virtualization of CPU | [6] |
| <b>Unit 2: Cloud Computing Architecture</b><br>Cloud Architecture, NIST Cloud Computing Reference Architecture, Public Private and Hybrid Clouds-IOT Services, Architectural Design Challenges, private versus hybrid cloud.                                                                                                                                  | [6] |
| <b>Unit 3: Cloud services and storage</b><br>Services mechanism-IaaS , Paas ,SaaS, Database as a service (DBaaS), benefits to Cloud adoption among users and providers, Cloud Storage, Storage-as-a-Service, Advantages of Cloud Storage                                                                                                                      | [6] |
| <b>Unit 4: Cloud development and security</b><br>Factors for cloud implementation, Cloud network topologies, automation in cloud development, Cloud security framework, cloud performance and Monitoring, host security for SaaS, host security IaaS, data security threats, cloud data challenges and security. Single sign- on for clouds, SAML             | [6] |
| <b>Unit 5: Administration for cloud and Risk factor</b><br>The AAA model, risk in cloud computing, risk assessment and management, Risk of failure and inadequate SLA, risk in physical infrastructure, risk with Software and application licensing. IAM Budget , subscription.                                                                              | [6] |
| <b>Unit 6: Adoption of cloud</b><br>Cloud migration services –Database server application, Cloud adoption framework- Adoption journey, strategy, plan, ready, adopt, manage, sequence, organize, case study, examples.                                                                                                                                        | [6] |



Page 8 | 31

*Basheer*  
Head of the Department  
Electronics & Computer Engineering  
SHARAD INSTITUTE OF TECHNOLOGY  
COLLEGE OF ENGINEERING  
Yadrav (Ichalkaranji) Dist.Kolhapur





**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**

Yadav (Ichalkaranji)-416121, Dist. – Kolhapur

**Text Books:**

1. Kailash Jayaswal, Jagannath kallakurchi, Donald j. houde, Dr. deven shah- DT Editorial services "Cloud Computing "2015
2. Rajkumar Buyya, Christian Vecchiola , S .ThamaraiSelvi,—Mastering Cloud Computingl, Tata Mcgraw Hill, 2013.

**Reference Books:**

- 1.Toby Velte, Anthony Velte, Robert Elsenpeter,"Cloud Computing-A Practical Approachl, Tata Mc graw Hill, 2009.
- 2.GeorgeReese,"Cloud Application Architectures:Building Applications and Infrastructure in the Cloud: TransactionalSystemsforEC2and Beyond (TheoryinPractice), O'Reilly, 2009.



*Pogbale*  
Page 9/31  
Head of the Department  
Electronics & Computer Engineering  
SHARAD INSTITUTE OF TECHNOLOGY  
COLLEGE OF ENGINEERING  
Yadav (Ichalkaranji) Dist.Kolhapur



**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**

Yadav (Ichalkaranji)-416121, Dist. – Kolhapur

**Satellite Communication**

|           |     |                         |       |           |
|-----------|-----|-------------------------|-------|-----------|
| 23EC4703C | PEC | Satellite Communication | 3-0-0 | 3-Credits |
|-----------|-----|-------------------------|-------|-----------|

| Teaching Scheme:    | Evaluation Scheme:                                                                          |
|---------------------|---------------------------------------------------------------------------------------------|
| Lectures: 3Hrs/Week | CA-I :10Marks<br>CA-II :10Marks<br>Mid Semester Exam: 30Marks<br>End Semester Exam: 50Marks |

**Pre-requisites:** Analog Communication & Digital Communication.

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                                              |
|-----|--------------------------------------------------------------|
| CO1 | Explain Orbital aspects involved in satellite communication. |
| CO2 | Illustrate various satellite subsystems.                     |
| CO3 | Analyze Link budget calculation.                             |
| CO4 | Categories Satellite Network System.                         |
| CO5 | Explain non-geostationary Satellite Systems.                 |
| CO6 | Elaborate modern applications of Satellite.                  |

**Course Contents:**

|                                                                                                                                                                                                                                                                                               |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>Unit 1: Introduction of satellite communication</b><br>Introduction, basic concept of satellite communication, Orbital Mechanics, Lookangle determination, Orbital perturbation, Orbital determination Launchers and Launch vehicles, Orbital effects in communication system performance. | [6] |
| <b>Unit 2: Satellite Subsystem</b><br>Introduction, Attitude and control system(AOCS),Telemetry, Tracking, Command and Monitoring, Power systems, Communication subsystem, Satellite antennas, Equipment reliability and space qualification.                                                 | [6] |
| <b>Unit 3: Satellite Link Design</b><br>Introduction, Basic transmission Theory, System Noise Temperature and G/T Ration, Design of Downlinks, Uplink Design, Design of specified C/N: Combining C/N and C/I values in Satellite Links.                                                       | [6] |
| <b>Unit 4: Satellite Networks</b><br>Reference architecture for satellite networks, basic characteristics of satellite networks, On-board connectivity with transparent processing, analogue transparent switching, On board connectivity with beam scanning.                                 | [6] |
| <b>Unit 5: Low Earth Orbit and Non Geo-Stationary Satellite System</b><br>Introduction, Orbit considerations, Coverage and Frequency Consideration, Delay and Throughput Consideration, Operational NGSO constellation design: Iridium, Teledesic.                                            | [6] |
| <b>Unit 6: Satellite Application</b><br>Communication Satellite-Digital DBS TV, Satellite Radio Broadcasting, Navigation Satellite, GPS Position Location Principles, GPS Receivers and codes.                                                                                                | [6] |
| <b>Text Books:</b><br>1. Satellite Communications-Timothy Pratt, Charles Bostian, Jeremy Allnut John Wiley & Sons (II                                                                                                                                                                         |     |



Page 10 | 31

*B. B. Bhat*  
**Head of the Department**  
**Electronics & Computer Engineering**  
**SHARAD INSTITUTE OF TECHNOLOGY**  
**COLLEGE OF ENGINEERING**  
**Yadav (Ichalkaranji) Dist. Kolhapur**





**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**

Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

Edition).

- 2.Satellite Communications-Anil k. Maine and Varsha Agaraval, Wiley Publications.
- 3.Satellite Technology Principles and Applications Anil K. Maini and Varsha Agarawal, Wiley Publications, Third Edition.
- 4.Satellite Communication Engineering- Wilbur L. Pritchard, Robert A Nelson and Henri G.Snyderhoud, 2nd Edition, Pearson Publications.

**Reference Books:**

- 1.Satellite Communications- Dennis Roody McGraw Hill Fourth Edition.
- 2.Satellite Communications- Gerard Maral and Michel Bousquet, Wiley Publication (5<sup>th</sup> Edition).
- 3.Satellite Communications systems Engineering, 2nd edition- Wilbur L. Pritchard, Henri G. Snyderhoud and Robert A. Nelson.



Page 11 | 31

*Postale*  
Head of the Department  
Electronics & Computer Engineering  
SHARAD INSTITUTE OF TECHNOLOGY  
COLLEGE OF ENGINEERING  
Yadrav (Ichalkaranji) Dist.Kolhapur



**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**  
Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

**Program Elective Course -IV**  
**Real Time Operating System**

|           |     |                            |       |           |
|-----------|-----|----------------------------|-------|-----------|
| 23EC4704A | PEC | Real Time Operating System | 3-0-0 | 3-Credits |
|-----------|-----|----------------------------|-------|-----------|

| Teaching Scheme:    | Evaluation Scheme:                                                                          |
|---------------------|---------------------------------------------------------------------------------------------|
| Lectures: 3Hrs/Week | CA-I :10Marks<br>CA-II :10Marks<br>Mid Semester Exam: 30Marks<br>End Semester Exam: 50Marks |

**Pre-requisites:** Digital Electronics.

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                                                                  |
|-----|----------------------------------------------------------------------------------|
| CO1 | Explain the key components and structure of RTOS.                                |
| CO2 | Construct task scheduling and synchronization mechanisms.                        |
| CO3 | Analyze embedded applications using RTOS APIs                                    |
| CO4 | Explain proficiency in debugging and resource optimization in real-time systems. |

**Course Contents:**

|                                                                                                                                                                                                                                                                                                                                                                                       |     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>Unit 1: Introduction</b><br>Introduction to UNIX/LINUX, Overview of Commands, File I/O,( open, create, close, lseek, read,write), Process Control ( fork, vfork, exit, wait, waitpid, exec.                                                                                                                                                                                        | [6] |
| <b>Unit 2: Real Time Operating Systems</b><br>Brief History of OS, Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, Defining a Task, tasks States and Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency. Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, Operations and Use. | [6] |
| <b>Unit 3: Objects, Services and I/O</b><br>Pipes, Event Registers, Signals, Other Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem.                                                                                                                                                                                                                       | [6] |
| <b>Unit 4: Exceptions, Interrupts and Timers</b><br>Exceptions, Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations.                                                                                                                                   | [6] |
| <b>Unit 5: Memory &amp; Resource Management</b><br>Static vs dynamic memory allocation, Memory fragmentation and heap management, Resource locking and deadlock resolution, Device drivers and I/O in RTOS.                                                                                                                                                                           | [6] |
| <b>Unit 6: RTOS-Based Application Development</b><br>Case study: Real-time embedded application using FreeRTOS / VxWorks / RTX<br>Porting RTOS to ARM Cortex-M, RTOS in IoT/Edge systems, Debugging and performance monitoring tools.                                                                                                                                                 | [6] |
| <b>Text Books:</b><br>1.Real Time Concepts for Embedded Systems – Qing Li, Elsevier, 2011.                                                                                                                                                                                                                                                                                            |     |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                               |     |







**Sharad Institute of Technology College of Engineering  
(An Autonomous Institute)**

Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

1. Embedded Systems- Architecture, Programming and Design by Rajkamal, 2007, TMH.
2. Advanced UNIX Programming, Richard Stevens
3. Embedded Linux: Hardware, Software and Interfacing – Dr. Craig Hollabaugh



Page 13 | 31

*Palata*  
Head of the Department  
Electronics & Computer Engineering  
SHARAD INSTITUTE OF TECHNOLOGY  
COLLEGE OF ENGINEERING  
Yadrav (Ichalkaranji) Dist. Kolhapur



**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**

Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

**Microwave Engineering**

|           |     |                       |       |           |
|-----------|-----|-----------------------|-------|-----------|
| 23EC4704B | PEC | Microwave Engineering | 3-0-0 | 3-Credits |
|-----------|-----|-----------------------|-------|-----------|

| Teaching Scheme:    | Evaluation Scheme:                                                                          |
|---------------------|---------------------------------------------------------------------------------------------|
| Lectures: 3Hrs/Week | CA-I :10Marks<br>CA-II :10Marks<br>Mid Semester Exam: 30Marks<br>End Semester Exam: 50Marks |

**Pre-requisites:** Good knowledge of Engineering Fundamentals of Physics and Electromagnetic.

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                                                                            |
|-----|--------------------------------------------------------------------------------------------|
| CO1 | Explain the working of the waveguide.                                                      |
| CO2 | Select a suitable microwave measurement instrument and perform the necessary measurements. |
| CO3 | Identify the use of microwave components and devices in microwave applications.            |
| CO4 | Explain the working principles of all the microwave tubes                                  |
| CO5 | Elaborate the microwave network analysis.                                                  |

**Course Contents:**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>Unit 1 Microwave Wave Guides</b><br>Introduction to Microwave Engineering: History of Microwaves, Microwave Frequency bands. Applications of Microwave, General solution for TEM, TE and TM waves, Parallel plate waveguide, and rectangular waveguide, Wave guide parameters, Introduction to the coaxial line, rectangular waveguide cavity resonators, Circular waveguide cavity resonators.                                                                                                                                                                                                       | [6] |
| <b>Unit 2 Microwave Components</b><br>Multi-port junctions: Construction and operation of E-plane, H-plane, Magic Tee, and Directional couplers. Ferrites components: - Ferrite Composition and characteristics, Faraday rotation, Construction and operation of Gyrator, Isolator, and Circulator. Striplines: Structural details and applications of strip lines, Microstrip lines, Parallel Strip lines, Coplanar Strip lines, and Shielded Strip Lines.                                                                                                                                              | [6] |
| <b>Unit 3 Microwave Measurements</b><br>Measurement devices: Slotted line, Tunable detector, VSWR meter, Power Meter, S-parameter measurement, frequency measurements, Power measurement, Attenuation measurement, Phase shift measurement, VSWR measurement, Impedance measurement, Q of cavity resonator measurement.                                                                                                                                                                                                                                                                                  | [6] |
| <b>Unit 4 Microwave Tubes:</b><br>Two cavity Klystron: Construction and principle of operation, velocity modulation, and bunching process, Applegate diagram. Reflex Klystron: Construction and principle of operation, velocity modulation, and bunching process, Applegate diagram, Oscillating modes, o/p characteristics. M-type tubes Magnetron: Construction and Principle of operation of 8 cavity cylindrical traveling wave magnetron, o/p characteristics, Applications. Slow wave devices: Advantages of slow wave devices, Helix TWT: Construction and principle of operation, Applications. | [6] |
| <b>Unit 5 Microwave Solid State Devices:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | [6] |







**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**  
Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

|                                                                                                                                                                                                                                                                                                                                     |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Varactor Diode, PIN Diode, Schottky Barrier Diode, Tunnel Diode, Gunn Diodes, IMPATT diode, and TRAPATT diode. Structural details, Principles of operation, various modes, specifications, and applications of all these devices.                                                                                                   |     |
| <b>Unit 6 Microwave Network Analysis</b><br>Introduction and applications of Impedance and Equivalent voltages and currents, Impedance and Admittance matrices, The Transmission (ABCD) matrix Scattering Matrix:- Significance, formulation, and properties. S-Matrix calculations for-2 port network junction                     | [6] |
| <b>Text Books:</b><br>1. Microwave Engineering – Annapurna Das, Sisir K Das TMH Publication, 2nd, 2010<br>2. Microwave Devices and circuits- Liao / Pearson Education<br>3. Antennas and Wave Propagation, John D. Krauss, Ronald J Marhefka, and Ahmad S Khan, 4th Special Indian Edition, McGraw- Hill Education Pvt. Ltd., 2010. |     |
| <b>Reference Books:</b><br>1. Microwave Engineering – David M Pozar, John Wiley India Pvt. Ltd., 3rd Edn, 2008<br>2. Microwave Engineering – Sushrut Das, Oxford Higher Education, 2nd Edn, 2015<br>3. Antennas and Wave Propagation – Harish and Sachidananda: Oxford University Press, 2007.                                      |     |





**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**  
Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

**Block Chain Management**

|           |     |                        |       |           |
|-----------|-----|------------------------|-------|-----------|
| 23EC4704C | PEC | Block Chain Management | 3-0-0 | 3-Credits |
|-----------|-----|------------------------|-------|-----------|

| Teaching Scheme:    | Evaluation Scheme:                                                                          |
|---------------------|---------------------------------------------------------------------------------------------|
| Lectures: 3Hrs/Week | CA-I :10Marks<br>CA-II :10Marks<br>Mid Semester Exam: 30Marks<br>End Semester Exam: 50Marks |

**Pre-requisites: .**

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                       |
|-----|---------------------------------------|
| CO1 | Explain structure of Blockchain.      |
| CO2 | Classify Bitcoin Blockchain.          |
| CO3 | Make use of Ethereum Blockchain.      |
| CO4 | Categories Enterprises Blockchain.    |
| CO5 | Explain Ethereum Smart Contracts.     |
| CO6 | Discuss Hyperledger Fabric Chaincode. |

**Course Contents:**

|                                                                                                                                                                                                                                                                                                                                             |     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>Unit 1: Introduction to Blockchain</b><br>What is Blockchain? The structure of Blockchains, Blockchain applications, The Blockchain life cycle, Consensus: The driving force of blockchains, blockchain in use: current blockchain in uses, future blockchain applications, Blockchain decision tree, Diving into Blockchain Technology. | [6] |
| <b>Unit 2: Bitcoin Blockchain</b><br>Introduction to Bitcoin, <b>Creation of coins, payments and double spending</b> , Bitcoin cash, The limitations of Bitcoin, Bitcoin Wallets, Bitcoin Scripts, Bitcoin Attacks, Bitcoin Network, Mining for bitcoins, proof of work, making your first paper wallet                                     | [6] |
| <b>Unit 3: Ethereum Blockchain</b><br>Introduction to Ethereum, Swarm and whisper, Remix IDE, Truffle Framework, Ethereum Networks, Ethereum Wallets, Ethereum Clients, Web3.js, NFT, Exploring the Ethereum Mainnet                                                                                                                        | [6] |
| <b>Unit 4: Enterprises Blockchain</b><br>Enterprise Blockchain, cross border payments, know your customer (KYC), dfood security, mortgage over blockchain, blockchain enabled trade, we trade-n trade finance network, supply chain financing, identity on blockchain.                                                                      | [6] |
| <b>Unit 5: Ethereum Smart Contracts</b><br>Introduction, Smart Contract Lifecycle, Solidity, Solidity Variables, Solidity Compilation and Deployment Solidity Functions Truffle Security Consideration.                                                                                                                                     | [6] |
| <b>Unit 6: Hyper ledger Fabric Chaincode</b><br>Hyperledger fabric- architecture, identities and policies, membership and access control,                                                                                                                                                                                                   | [6] |







**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**  
Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

channels, transaction validation, writing smart contracts using hyperledger fabric, overview of ripple and corda.

**Text Books:**

1. Draft version of “S. Shukla, M. Dhawan, S. Sharma, S. Venkatesan, ‘Blockchain Technology: Cryptocurrency and Applications’, Oxford University Press, 2019.
- Josh Thompson, ‘Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming’, Create Space Independent Publishing Platform, 2017.
3. Melanie Swan, “Blockchain: Blueprint for a New Economy”, O’Reilly, 2015.

**Reference Books:**

1. Daniel Drescher, “Blockchain Basics”, Apress; 1st Edition, 2017.
- Anshul Kaushik, “Blockchain and Crypto Currencies”, Khanna Publishing House, Delhi.
3. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O’Dowd, Venkatraman Ramakrishna, “Hands-On Block Chain with Hyperledger: Building Decentralized Applications with Hyperledger Fabric and Composer”, Import, 2018.
4. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to Build Smart Contracts for Ethereum and Blockchain”, Packt Publishing





**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**  
Yadav (Ichalkaranji)-416121, Dist. – Kolhapur

**Multidisciplinary Minor-V**  
**Medical Image Processing**

|          |     |                          |       |           |
|----------|-----|--------------------------|-------|-----------|
| 23ECMDA5 | MDM | Medical Image Processing | 3-0-0 | 3-Credits |
|----------|-----|--------------------------|-------|-----------|

| Teaching Scheme:    | Evaluation Scheme:                                                                          |
|---------------------|---------------------------------------------------------------------------------------------|
| Lectures: 3Hrs/Week | CA-I :10Marks<br>CA-II :10Marks<br>Mid Semester Exam: 30Marks<br>End Semester Exam: 50Marks |

**Pre-requisites:** Digital Image Processing, Signal Processing Basics

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                                                                                    |
|-----|----------------------------------------------------------------------------------------------------|
| CO1 | Summarise various medical imaging modalities and their digital representation.                     |
| CO2 | Explain the characteristics and challenges in processing medical images.                           |
| CO3 | Apply various image enhancement techniques to improve the quality of medical images.               |
| CO4 | Categorize segmentation techniques for isolating regions of interest in medical images.            |
| CO5 | Conclude meaningful features from medical images for classification and diagnosis.                 |
| CO6 | Build image registration and fusion to align and combine medical images from different modalities. |

**Course Contents:**

|                                                                                                                                                                                                                                                                                                                     |     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>Unit 1: Introduction to Medical Imaging</b><br>Introduction to medical image processing, Imaging modalities: X-ray, CT, MRI, PET, Ultrasound, Nuclear imaging, Characteristics of medical images, Digital image representation and formats (DICOM), Challenges in medical image analysis.                        | [6] |
| <b>Unit 2: Medical Image Enhancement Techniques</b><br>Noise in medical images, Histogram equalization, Contrast stretching, Filtering: Spatial and frequency domain, Edge enhancement, Adaptive filtering techniques.                                                                                              | [6] |
| <b>Unit 3: Medical Image Segmentation</b><br>Thresholding and region-based segmentation, Edge-based segmentation, Clustering-based segmentation (K-means, Fuzzy C-means), Active contours and level sets, Evaluation metrics: Dice coefficient, Jaccard index.                                                      | [6] |
| <b>Unit 4: Feature Extraction and Description</b><br>Texture, shape, intensity, and morphological features, Feature descriptors: SIFT, HOG, LBP, Feature selection and dimensionality reduction (PCA, LDA).                                                                                                         | [6] |
| <b>Unit 5: Image Registration and Fusion</b><br>Need for image registration, Rigid and non-rigid registration techniques, Intensity-based and feature-based registration, Multi-modal image fusion techniques.                                                                                                      | [6] |
| <b>Unit 6: Classification and AI in Medical Imaging</b><br>Supervised and unsupervised learning for image classification, Deep learning in medical imaging (CNNs, U-Nets, Applications: Tumor detection, Organ segmentation, Disease diagnosis, Ethical issues and regulatory considerations in medical imaging AI. | [6] |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                  |     |







**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**

Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

1. **J.M. Boone and J.A. Seibert**, The Essential Physics of Medical Imaging, Lippincott Williams & Wilkins.
2. **Isaac Bankman**, Handbook of Medical Image Processing and Analysis, Academic Press.
3. **Rafael C. Gonzalez and Richard E. Woods**, Digital Image Processing, Pearson (for foundational concepts).

**Reference Books:**

1. **K. Doi**, Computer-Aided Diagnosis in Medical Imaging, World Scientific.
2. **Suri et al.**, Advanced Algorithms for Medical Image Analysis, Wiley.
3. Research papers from IEEE Transactions on Medical Imaging, Medical Image Analysis Journal, etc.



Page 19 | 31

*Chavala*  
Head of the Department  
Electronics & Computer Engineering  
SHARAD INSTITUTE OF TECHNOLOGY  
COLLEGE OF ENGINEERING  
Yadrav (Ichalkaranji) Dist. Kolhapur



**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**

Yadav (Ichalkaranji)-416121, Dist. – Kolhapur

**Advanced Data Visualization**

|          |     |                             |       |           |
|----------|-----|-----------------------------|-------|-----------|
| 23ECMDB5 | MDM | Advanced Data Visualization | 3-0-0 | 3-Credits |
|----------|-----|-----------------------------|-------|-----------|

| Teaching Scheme:    | Evaluation Scheme:                                                                          |
|---------------------|---------------------------------------------------------------------------------------------|
| Lectures: 3Hrs/Week | CA-I :10Marks<br>CA-II :10Marks<br>Mid Semester Exam: 30Marks<br>End Semester Exam: 50Marks |

**Pre-requisites: .**

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                                                          |
|-----|--------------------------------------------------------------------------|
| CO1 | Explain the data analytics lifecycle and types of analytics              |
| CO2 | Make use of data preprocessing and spreadsheet-based analysis techniques |
| CO3 | Examine SQL concepts and query structures for data handling              |
| CO4 | Analyze statistical methods for datasets                                 |
| CO5 | Interpret data using visualization and reporting techniques              |
| CO6 | Discuss programming concepts used in data analytics                      |

**Course Contents:**

|                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>Unit 1: Introduction &amp; Data Analytics Fundamentals</b><br>Definition and importance of data analytics, Types of analytics: Descriptive, Diagnostic, Predictive, Prescriptive, Data analytics lifecycle (CRISP-DM), Types of data: Structured, unstructured, semi-structured, Role of data analysts and business intelligence                                                                                             | [6] |
| <b>Unit 2: Data Foundations &amp; Spreadsheet Modeling (Excel)</b><br>Data collection and preprocessing concepts, Data cleaning techniques, Introduction to spreadsheet tools and functions, Concept of Pivot Tables and data summarization, Data validation and basic reporting concepts                                                                                                                                       | [6] |
| <b>Unit 3: Database Management &amp; SQL</b><br>Introduction to RDBMS, SQL fundamentals: SELECT, WHERE, ORDERBY, Joins: INNER, LEFT, RIGHT, FULL (conceptual understanding), Aggregation: GROUP BY, AVERAGE Introduction to sub-queries and views.                                                                                                                                                                              | [6] |
| <b>Unit 4: Statistics &amp; Analytical Thinking</b><br>Descriptive statistics: Mean, Median, Mode, Variance, Standard Deviation, Probability basics and distributions (Normal, Binomial), Correlation and regression (conceptual), Hypothesis testing: Z-test, T-test (basic understanding), Confidence intervals (introduction).                                                                                               | [6] |
| <b>Unit 5: Data Visualization &amp; Reporting (BI Tools)</b><br>Principles of data visualization, Types of charts, Data storytelling concepts - Narrative building with data, communicating insights effectively, Audience-centric visualization, Connecting with data - Contextual interpretation, Insight generation and decision-making, Introduction to BI tools (Tableau, Power BI), Dashboard design principles and KPIs. | [6] |
| <b>Unit 6: Programming for Analytics (Python/R)</b><br>Introduction to Python/R (overview), Basic programming constructs: variables, loops, functions, Concept of data manipulation (Pandas/ NumPy – theoretical), Overview of data                                                                                                                                                                                             | [6] |







**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**  
Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

Analysis workflow, Introduction to machine learning concepts (high-level)

**Text Books:**

1. Data Analytics Made Accessible – Anil Maheshwari – McGraw Hill Education
2. Data Science for Business – Foster Provost, Tom Fawcett – O'Reilly Media
3. Practical Statistics for Data Scientists – Peter Bruce, Andrew Bruce – O'Reilly Media
4. Python for Data Analysis – Wes McKinney – O'Reilly Media
5. Learning SQL – Alan Beaulieu – O'Reilly Media

**Reference Books:**

1. Storytelling with Data – Cole Nussbaumer Knaflitz – Wiley
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow – Aurélien Géron – O'Reilly Media
3. Microsoft Excel Data Analysis and Business Modeling – Wayne L. Winston – Microsoft Press Data Storytelling and Visualization with Tableau: A Hands-on Approach – Prachi Manoj Joshi, Parikshit Narendra Mahalle



Page 21 | 31

*Prachi*  
Head of the Department  
Electronics & Computer Engineering  
SHARAD INSTITUTE OF TECHNOLOGY  
COLLEGE OF ENGINEERING  
Yadrav (Ichalkaranji) Dist. Kolhapur



**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**  
Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

**Industrial Automation and Control**

|          |     |                                   |       |           |
|----------|-----|-----------------------------------|-------|-----------|
| 23ECMDC5 | MDM | Industrial Automation and Control | 3-0-0 | 3-Credits |
|----------|-----|-----------------------------------|-------|-----------|

| Teaching Scheme:    | Evaluation Scheme:                                                                          |
|---------------------|---------------------------------------------------------------------------------------------|
| Lectures: 3Hrs/Week | CA-I :10Marks<br>CA-II :10Marks<br>Mid Semester Exam: 30Marks<br>End Semester Exam: 50Marks |

**Pre-requisites:**PLC

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                                                                        |
|-----|----------------------------------------------------------------------------------------|
| CO1 | Explain the basic concepts and importance of industrial automation systems.            |
| CO2 | Identify and apply appropriate sensors and transducers for industrial applications     |
| CO3 | Develop ladder logic programs and interface components with PLCs.                      |
| CO4 | Make use of the operation of SCADA and HMI systems for process monitoring and control. |
| CO5 | Examine control strategies and communication protocols for automated systems.          |
| CO6 | Interpret various industrial actuators, drives, and safety systems used in automation. |

**Course Contents:**

|                                                                                                                                                                                                                                                                                                                                                                                           |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>Unit 1: Introduction to Industrial Automation</b> <ul style="list-style-type: none"><li>• Definition, benefits, and scope of automation</li><li>• Types of automation: fixed, programmable, flexible</li><li>• Components of automation systems</li><li>• Overview of control system hierarchy</li><li>• Introduction to SCADA, DCS, and PLC</li></ul>                                 | [6] |
| <b>Unit 2: Sensors and Transducers</b> <ul style="list-style-type: none"><li>• Introduction to sensors and transducers</li><li>• Classification: active/passive, analog/digital</li><li>• Industrial sensors: temperature, pressure, proximity, level, flow, etc.</li><li>• Signal conditioning and data acquisition systems</li><li>• Interfacing sensors with control systems</li></ul> | [6] |
| <b>Unit 3: Programmable Logic Controllers (PLCs)</b> <ul style="list-style-type: none"><li>• Basics of PLCs: architecture and working</li><li>• I/O modules, memory organization, scan cycle</li><li>• Ladder logic fundamentals</li></ul>                                                                                                                                                | [6] |







**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**  
Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

|                                                                                                                                                                                                                                                                                                                                                              |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <ul style="list-style-type: none"><li>Timers, counters, and arithmetic operations</li><li>Programming and troubleshooting</li></ul>                                                                                                                                                                                                                          |     |
| <b>Unit 4: Human Machine Interface (HMI) and Supervisory Control</b> <ul style="list-style-type: none"><li>Role and architecture of HMI</li><li>HMI design considerations</li><li>SCADA systems: architecture, functions, applications</li><li>Communication protocols: Modbus, Profibus, OPC, Ethernet</li><li>Data logging and remote monitoring</li></ul> | [6] |
| <b>Unit 5: Control Strategies and Industrial Communication</b><br>ON-OFF, PID control systems in automation<br>Tuning of PID controllers<br>Industrial networks: Fieldbus, DeviceNet, CAN<br>Wireless automation and IIoT (Industrial Internet of Things)<br>Introduction to Industry 4.0                                                                    | [6] |
| <b>Unit 6: Drives, Actuators and Safety Systems</b><br>Electric drives: AC, DC drives, and servo systems<br>Pneumatic and hydraulic actuators<br>Safety in automation: emergency stops, interlocks<br>Introduction to Safety PLCs and safety standards (ISO/IEC)<br>Case studies and applications in industries                                              | [6] |
| <b>Text Books:</b> <ol style="list-style-type: none"><li>"Industrial Automation and Control" by S.K. Singh – McGraw Hill</li><li>"Programmable Logic Controllers" by Frank D. Petruzella – McGraw Hill</li><li>"Automation, Production Systems, and Computer-Integrated Manufacturing" by Mikell P. Groover</li></ol>                                        |     |
| <b>Reference Books:</b> <ol style="list-style-type: none"><li>"Mechatronics and Measurement Systems" by David G. Alciatore, Michael B. Hestand</li><li>"Process Control Instrumentation Technology" by Curtis D. Johnson</li><li>"Industrial Instrumentation and Control" by S.K. Singh</li></ol>                                                            |     |





**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**  
Yadav (Ichalkaranji)-416121, Dist. – Kolhapur

**Very Large-Scale Integration Design Laboratory**

|          |     |                                                |       |           |
|----------|-----|------------------------------------------------|-------|-----------|
| 23EC4705 | PCC | Very Large-Scale Integration Design Laboratory | 0-0-2 | 1-Credits |
|----------|-----|------------------------------------------------|-------|-----------|

|                                                 |                                                                                           |
|-------------------------------------------------|-------------------------------------------------------------------------------------------|
| <b>Teaching Scheme:</b><br>Practical: 2Hrs/Week | <b>Evaluation Scheme:</b><br>CA-I:15Marks<br>CA-II :15Marks<br>End Semester Exam: 20Marks |
|-------------------------------------------------|-------------------------------------------------------------------------------------------|

**Pre-requisites:** Digital logic Design

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                                                                                                                                  |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------|
| CO1 | Develop VHDL code for Adder, mux, decoder, encoder, comparator.                                                                                  |
| CO2 | Make use of VHDL statements and operators and FSM design basics to build code for sequential circuits (sequence detector, serial adder, counter) |
| CO3 | Build verilog code for mux, decoder, counter                                                                                                     |

**Experiment List: Minimum 8 Experiment should be Conducted.**

| Sr. no. | Experiment Name.                                                                                                                                                           |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | Make use of appropriate modelling style and Write VHDL code to verify truth table of Half Adder, Full Adder, Half Subtractor, Full subtractor                              |
| 2       | Develop VHDL code for decoder, encoder                                                                                                                                     |
| 3       | Build VHDL code to verify truth table of 4:1 ,2:1,8:1 MUX<br>Design 16: 1 mux using 4:1 mux develop VHDL code using structural modeling                                    |
| 4       | Develop code for comparator, parity generator, parity checker                                                                                                              |
| 5       | Make use of VHDL shift and rotate operators to Develop code for barallel shifter                                                                                           |
| 6       | Develop FSM to detect sequence 1010 and write VHDL code                                                                                                                    |
| 7       | Design FSM for serial adder and show simulation using VHDL code                                                                                                            |
| 8       | Build VHDL code for LFSR, bus arbiter                                                                                                                                      |
| 9       | Design Universal Shift Register use load and shift line to control operation to Simulate (SISO, SIPO, PIPO, PISO) modes of operation make use of VHDL structural modelling |
| 10      | Design FSM for even and odd counter simulation in VHDL                                                                                                                     |
| 11      | Develop verilog code to demonstrate behavior of Decoder, encoder, mux                                                                                                      |
|         | Build verilog code to demonstrate counter operation                                                                                                                        |







**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**

Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

**Computer Network and Security Laboratory**

|          |     |                                          |       |           |
|----------|-----|------------------------------------------|-------|-----------|
| 23EC4706 | PCC | Computer Network and Security Laboratory | 0-0-2 | 1-Credits |
|----------|-----|------------------------------------------|-------|-----------|

|                                                 |                                                                                             |
|-------------------------------------------------|---------------------------------------------------------------------------------------------|
| <b>Teaching Scheme:</b><br>Practical: 2Hrs/Week | <b>Evaluation Scheme:</b><br>CA-I: 15Marks<br>CA-II : 15Marks<br>End Semester Exam: 20Marks |
|-------------------------------------------------|---------------------------------------------------------------------------------------------|

**Pre-requisites:** NIL

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                                                                              |
|-----|----------------------------------------------------------------------------------------------|
| CO1 | Demonstrate fundamentals of data communication and network devices.                          |
| CO2 | Make use of Different TCP/IP services.                                                       |
| CO3 | Examine various protocols in network system and analyze Encryption and Decryption algorithm. |

**Experiment List: Minimum 8 Experiment should be Conducted.**

| Sr. no. | Name of the Experiments.                                                |
|---------|-------------------------------------------------------------------------|
| 1       | Demonstration of Network hardware devices and Computer Hardware devices |
| 2       | Demonstration of IP ((v4/v6) address configuration and setup.           |
| 3       | Demonstration of network topologies(any two)                            |
| 4       | Installation and configuration of operating system.                     |
| 5       | Study of DNS, SMTP & POP3 Determine the local host address.             |
| 6       | Study of network monitoring tool/software.                              |
| 7       | Simulating LAN or WAN using suitable network simulator.                 |
| 8       | Echo Client and Server Program Using TCP or UDP or both in C/Java       |
| 9       | Write a program for Encryption and Decryption                           |



Page 25 | 31

*Dr. Balu*  
Head of the Department  
Electronics & Computer Engineering  
SHARAD INSTITUTE OF TECHNOLOGY  
COLLEGE OF ENGINEERING  
Yadrav (Ichalkaranji) Dist. Kolhapur



**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**

Yadav (Ichalkaranji)-416121, Dist. – Kolhapur

**Research Methodology**

|          |    |                             |       |           |
|----------|----|-----------------------------|-------|-----------|
| 23EC4707 | RM | <b>Research Methodology</b> | 3-0-0 | 3 Credits |
|----------|----|-----------------------------|-------|-----------|

|                                                |                                                                                                                              |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| <b>Teaching Scheme:</b><br>Lecture: 3 hrs/week | <b>Evaluation Scheme:</b><br>CA-I: 10 Marks<br>CA-II: 10 Marks<br>Mid Semester Exam: 30 Marks<br>End Semester Exam: 50 Marks |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|

**Pre-Requisites:**

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                                                             |
|-----|-----------------------------------------------------------------------------|
| CO1 | Summarize the fundamentals of research concepts                             |
| CO2 | Classify different types of research concepts                               |
| CO3 | Identify the different methods of sampling data collection and its analysis |
| CO4 | Discover component structure and referencing styles of research report      |
| CO5 | Justify the need of research ethics                                         |
| CO6 | Elaborate use of recent ICT Tools for research                              |

**Course Contents:**

|                                                                                                                                                                                                                                                                                                                                                                                            |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>Unit 1 -Introduction to Research:</b><br>The concept of research, characteristics of good research, Application of Research, Meaning and sources of Research problem, characteristics of good Research problem, Research process, outcomes, application of Research, Meaning and types of Research hypothesis, Importance of Review of Literature, Organizing the Review of Literature. | [6] |
| <b>Unit 2 -Types of Research:</b> Types of research, pure (basic, fundamental) and applied research, qualitative and quantitative. Research Design: Meaning, need, types of research design – Exploratory, Descriptive, Casual research Design, Components of research design, and Features of good Research design. Experiments, surveys and case study Research design                   | [6] |
| <b>Unit 3-Literature Survey</b><br>Importance of literature survey, planning a literature search, Identifying key concepts and key words, locating relevant literature, Reliability of a source.                                                                                                                                                                                           | [6] |
| <b>Unit 4-Research Report:</b> Research report and its structure, journal articles – Components of journal article. Explanation of various components. Structure of an abstract and keywords. Thesis and dissertations. Components of thesis and dissertations. Referencing styles and bibliography.                                                                                       | [6] |
| <b>Unit 5- Ethics in Research:</b> Plagiarism - Definition, different forms, consequences, unintentional plagiarism, copyright infringement, collaborative work. Qualities of good Researcher.                                                                                                                                                                                             | [6] |
| <b>Unit 6- ICT Tools for Research:</b> Role of computers in research, maintenance of data                                                                                                                                                                                                                                                                                                  | [6] |



Page 26 | 31

*Page 26*  
Head of the Department  
Electronics & Computer Engineering  
SHARAD INSTITUTE OF TECHNOLOGY  
COLLEGE OF ENGINEERING  
Yadav (Ichalkaranji) Dist. Kolhapur





**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**

Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

using software such as Mendeley, Endnote, Tabulation and graphical presentation of research data and software tools. **Web search:** Introduction to Internet, use of Internet and WWW, using search engines and advanced search tools.

**Reference Books:**

1. Alex Rosenberg, "Philosophy of Science: A contemporary introduction" Second Edition, Routledge, 2005.
2. Bordens, K. S. and Abbott, B. B., "Research Design and Methods – A Process Approach", 8th Edition, McGraw-Hill, 2011.
3. Michael P. Marder, "Research Methods for Science", Cambridge University Press, 2015

**Text Books:**

1. Praveen Chaddah, "Ethics in Competitive Research: Do not get scooped; do not get plagiarized" 2018.
2. C. R. Kothari, "Research Methodology – Methods and Techniques", 2nd Edition, New Age International Publishers.
3. C. George Thomas: "Research Methodology and Scientific Writing", Springer Nature, 2015.
4. Davis, M., Davis K., and Dunagan M., "Scientific Papers and Presentations", 3rd Edition, Academic Press, Elsevier Inc.



Page 27 | 31

*[Signature]*  
Head of the Department  
Electronics & Computer Engineering  
SHARAD INSTITUTE OF TECHNOLOGY  
COLLEGE OF ENGINEERING  
Yadrav (Ichalkaranji) Dist Kolhapur



**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**

Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

**Seminar**

|          |    |         |       |           |
|----------|----|---------|-------|-----------|
| 23EC4708 | RM | Seminar | 0-0-2 | 1-Credits |
|----------|----|---------|-------|-----------|

| Teaching Scheme:     | Evaluation Scheme:         |
|----------------------|----------------------------|
| Practical: 2Hrs/Week | CA-I:15Marks               |
|                      | CA-II :15Marks             |
|                      | End Semester Exam: 20Marks |

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                                                            |
|-----|----------------------------------------------------------------------------|
| CO1 | Demonstrate the sound technical knowledge of the selected technical topic. |
| CO2 | Apply technical presentation skill.                                        |
| CO3 | Discuss and develop the progress report.                                   |

**Course Content:**

Student shall choose a topic of his/her interest in consultation with faculty in the Electronics and Telecommunication Engineering Department. The topic for seminar may be related to Recent Developments in Electronics and Telecommunication Engineering area and/or interdisciplinary area. Student shall attempt to collect necessary information and present a summary indicating comprehension of the topic and acquired depth of knowledge. A brief report on topic of seminar shall be submitted. Evaluation shall be based on report and power point presentation.



Page 28 | 31

*B. Balakrishna*

Head of the Department  
Electronics & Computer Engineering  
SHARAD INSTITUTE OF TECHNOLOGY  
COLLEGE OF ENGINEERING  
Yadrav (Ichalkaranji) Dist. Kolhapur





**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**

Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

**Capstone Project – II**

|          |      |                       |       |           |
|----------|------|-----------------------|-------|-----------|
| 23EC4709 | PROJ | Capstone Project - II | 0-0-4 | 2-Credits |
|----------|------|-----------------------|-------|-----------|

| Teaching Scheme:      | Evaluation Scheme:                                          |
|-----------------------|-------------------------------------------------------------|
| Practical: 4 Hrs/Week | CA-I:25Marks<br>CA-II:25Marks<br>End Semester Exam: 50Marks |

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                                                                      |
|-----|--------------------------------------------------------------------------------------|
| CO1 | Develop the sound technical knowledge of the selected technical topic.               |
| CO2 | Design and implement innovative solutions using modern engineering tools techniques. |
| CO3 | Discuss and develop the project report                                               |

**Course Content:**

Since Mega Project Phase-II is in continuation to Mega Project Phase-I, the students are expected to complete the total project by the end of semester VII. After completion of project work, they are expected to submit the project report including the work done in Phase-I and Phase-II.

The report shall be comprehensive and presented typed on A4 size sheets and **hard bound**. The number of copies to be submitted is number of students plus two. The assessment would be carried out by the panel of examiners (Guide and Project Evaluation Members) for both, term work and oral examinations.

The project work should be published in any one of the national/international quality conference or reputed journal.

Report shall summarize the literature survey; spell out the scope of work, methodology and results. Viva-voce Examination shall be based on work carried out by the student





## Sharad Institute of Technology College of Engineering

(An Autonomous Institute)

Yadav (Ichalkaranji)-416121, Dist. – Kolhapur

### Values and Ethics

|          |     |                   |       |       |
|----------|-----|-------------------|-------|-------|
| 23EC4710 | VEC | Values and Ethics | 1-0-0 | Audit |
|----------|-----|-------------------|-------|-------|

|                         |                               |
|-------------------------|-------------------------------|
| <b>Teaching Scheme:</b> | <b>Evaluation Scheme:</b>     |
| Lecture: 1 Hrs/Week     | CA-I:25Marks<br>CA-II:25Marks |

#### Pre-requisites:

**Course Outcomes:** At the end of the course, students will be able to:

|     |                                                                                                                                                                                    |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO1 | Interpret the principles of ethics and human values by examining their influence on personal behavior, public conduct, and value formation through family, society, and education. |
| CO2 | Demonstrate improved attitude, morals, aptitude, and integrity in contributing positively to society                                                                               |
| CO3 | Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.                   |
| CO4 | Explain the significance of value inputs in a classroom and start applying them in their life and profession.                                                                      |
| CO5 | Analyze publication ethics and misconduct to ensure adherence to ethical standards, authorship guidelines, and responsible research dissemination.                                 |
| CO6 | Evaluate the role of ethics, professional values, and gender sensitization in promoting responsible and equitable conduct in engineering and public life.                          |

#### Course Contents:

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>Unit 1: Ethics and Human Interface</b><br>Ethics and Human Interface, Essence, determinants and consequences of Ethics in human actions; Dimensions of ethics; ethics in private and public relationships Human Values – lessons from the lives and teachings of great leaders, reformers and administrators, Role of family, society in inculcating values, role of educational institutions in inculcating values.                                                                                                                                                                     | [4] |
| <b>Unit 2: Attitude, Morals, Aptitude, Integrity towards Society</b><br>Attitude: content, structure, function, Attitude and its influence and relation with thought and behaviour, Aptitude and foundational values towards society, integrity, impartiality and non-partisanship, objectivity, dedication towards society, empathy, tolerance and compassion intelligence-concepts, and their utilities and application.                                                                                                                                                                  | [4] |
| <b>Unit 3: Understanding Harmony in the Human Being - Harmony in Myself</b><br>Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body', Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya, Understanding harmony in the Family. | [4] |
| <b>Unit 4: Value Education</b><br>Need, Guidelines, content and process for Value Education, Self-exploration - Natural                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |







**Sharad Institute of Technology College of Engineering**  
**(An Autonomous Institute)**

Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Acceptance and Experiential Validation, Continuous Happiness and Prosperity, Relationship and Physical Facilities, Method to fulfill the above human aspirations: understanding and living in harmony at various levels.                                                                                                                                                                                                                                                                                                                                                                                                                                                         | [4] |
| <b>Unit 5: Publication Ethics</b><br>Publication Ethics: Introduction, Scope & importance, Best practices/standards initiatives & Guidelines: COPE, WAME, etc., Conflict of Interest,<br>Publication Misconduct: definition, concept, problems that lead to unethical behaviour & Vice versa, Violation of Publication Ethics, Authorship & Contributor ship, Identification of Publication misconduct, complaints & appeals, Predatory publishers & Journals.                                                                                                                                                                                                                   | [4] |
| <b>Unit 6: Ethics and Gender Sensitization</b><br>Ethics - Meaning, Importance, & Types of Ethics, Values and Attitudes of Professional Engineers, Seven Principles of Public Life.<br>Gender Sensitization: Introduction, Sex vs. Gender, Social construction of Gender, Gender Roles, Gender Stereotypes, Ending violence against girls/ women: Advancing safety and rights, Gender Equality.                                                                                                                                                                                                                                                                                  | [4] |
| <b>Text Books:</b> <ol style="list-style-type: none"><li>1. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.</li><li>2. M Govindrajran, S Natrajan &amp; V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.</li><li>3. Neeraj Kumar, "Lexicon for Ethics, Integrity &amp; Aptitude", Chronicle Publication, 2016.</li><li>4. Santosh Ajmera, Nand Kishor Reddi, "Ethics - Integrity and Aptitude", Tata Mc Graw Hill Publication, 2014.</li><li>5. M. Karthikeyan "Ethics, Integrity and Aptitude", Tata Mc Graw Hill Publication, 2015.</li></ol>         |     |
| <b>Reference Books:</b> <ol style="list-style-type: none"><li>1. Ivan Illich, 1974, Energy &amp; Equity, The Trinity Press, Worcester, and Harper Collins, USA.</li><li>2. A N Tripathy, 2003, Human Values, New Age International Publishers.</li><li>3. E G Seebauer &amp; Robert L. Berry, 2000, Fundamentals of Ethics for Scientists &amp; Engineers, Oxford University Press.</li><li>4. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.</li><li>5. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.</li><li>6. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.</li></ol> |     |

