Shri Vile Parle Kelavani Mandal's

Dwarkadas J. Sanghvi College of Engineering

(Autonomous College Affiliated to the University of Mumbai)

Scheme and detailed Syllabus (DJ19)

of

Minor Degree Programs

Revision: 1 (2022)

With effect from the Academic Year: 2022-2023

B.Tech Degree in	Honors Degree offered	Minor Degree offered
Chemical Engineering	Green Technology and Sustainability Engineering	Intelligent Automation and Applied Analytics
		Web Application Development
		Data Science
		Robotics
		Artificial Intelligence and Machine Learning
		Electric Vehicles
		Industry 4.0 & IoT
Electronics Engineering	Intelligent Automation and Applied Analytics	Green Technology and Sustainability Engineering
		Web Application Development
		Data Science
		Robotics
		Artificial Intelligence and Machine Learning
		Electric Vehicles
		Industry 4.0 & IoT
EXTC Engineering	Artificial Intelligence and Machine Learning	Green Technology and Sustainability Engineering
		Web Application Development
		Data Science
	Intelligent Connectivity : 5G & IoT	Robotics
		Electric Vehicles
		Intelligent Automation and Applied Analytics
Information Technology	DevOps (Development and Operations)	Green Technology and Sustainability Engineering
		Web Application Development
		Data Science
		Robotics
		Electric Vehicles
		Industry 4.0 & IoT
		Intelligent Automation and Applied Analytics

B.Tech Degree in	Honors Degree offered	Minor Degree offered
Computer Engineering	Intelligent Computing	Green Technology and Sustainability Engineering
		Intelligent Automation and Applied Analytics
		Data Science
		Robotics
		Electric Vehicles
		Artificial Intelligence and Machine Learning
		Industry 4.0 & IoT
Mechanical Engineering	Electric Vehicles	Green Technology and Sustainability Engineering
		Web Application Development
		Data Science
	Robotics	Artificial Intelligence and Machine Learning
		Industry 4.0 & IoT
		Intelligent Automation and Applied Analytics
Computer Science and Engineering (Data Science)	Computational Finance	Green Technology and Sustainability Engineering
		Robotics
		Electric Vehicles
		Artificial Intelligence and Machine Learning
		Industry 4.0 & IoT
		Intelligent Automation and Applied Analytics
		Web Application Development

Continuous Assessment (A):

Course	Assessment Tools	Marks	Time (hrs.)
Theory	One Term test (based on 40 % syllabus)	25 each (Avg.25)	1
	Second Term test (next 40 % syllabus) / presentation / assignment / course project / group discussion / any other.		as applicable
Audit course	Performance in the assignments / quiz / power point presentation / poster presentation / group project / any other tool.	--	
Laboratory	Performance in the laboratory and documentation.	25	
Tutorial	Performance in each tutorial & / assignment.	25	
Laboratory &Tutorial	Performance in the laboratory and tutorial.	25	

The final certification and acceptance of term work will be subject to satisfactory performance upon fulfilling minimum passing criteria in the term work / completion of audit course.

Semester End Assessment (B):

Course	Assessment Tools	Marks	Time (hrs.)
Theory / * Computer based	Written paper based on the entire syllabus.	75	3
	* Computer based assessment in the college premises.		
Oral	Questions based on the entire syllabus.	25	as applicable
Practical	Performance of the practical assigned during the examination and the output / results obtained.	25	2
Oral & Practical	Project based courses - Performance of the practical assigned during the examination and the output / results obtained. Based on the practical performed during the examination and on the entire syllabus.	as per the scheme	2

Prepared by Checked by Department Coordinator Principal

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Proposed scheme for Minor in Green Technology and Sustainability Engineering
(Academic Year 2022-2023)

Sr.	Course Code	Course	Teaching Scheme (hrs.)				Continuous Assessment (A) (marks)			Semester End Assessment (B) (marks)					(A+B)	Total Credits
			Th	P	T	Credits	Th	T/W	Total CA (A)	Th / Cb	O	P	O & P	Total SEA (B)		
Sem V																
1	DJ19MN1C1	Green Technologies and Practices	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
Sem VI																
2	DJ19MN1C2	Renewable Energies	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
3	DJ19MN1L1	Renewable Energies Laboratory	--	2	--	1	--	25	25	--	--	--	25	25	50	1
Sem VII																
3	DJ19MN1C3	Green Building and Infrastructure Engineering	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
4	DJ19MN1L2	Green Building and Infrastructure Engineering Laboratory	--	2	--	1	--	25	25	--	--	--	25	25	50	**1**
Sem VIII																
5	DJ19MN1C4	Sustainable Built Environmental Engineering	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
		Total	**16**	**4**	**0**	**18**	**100**	**50**	**150**	**300**	**0**	**0**	**50**	**350**	**500**	**18**

Minor in Green Technologies and Sustainability Engineering **Semester: V**

Program: Common for All Programs (except Chemical Engineering)

Course: Green Technologies and Practices (DJ19MN1C1)

Pre-requisite: --

1. Engineering Chemistry I
2. Engineering Chemistry II

Objectives:

1. To acquire Knowledge on the concept of green technologies.
2. To understand the principles of green chemistry in the Energy efficient technologies.
3. To analyze the methods of reducing CO_2 levels in atmosphere for cleaner production project development and implementation.
4. To evaluate the methods of pollution prevention and cleaner production awareness plan.
5. To analyze the application of energy efficacy.
6. To apply the knowledge of green fuels during implementation.

Outcomes: On completion of the course, the learner will be able to:

1. Enlist different concepts of green technologies in a project.
2. Describe the principles of green chemistry in the Energy efficient technologies.
3. Select the best method for the carbon credits of various activities for cleaner production project development and implementation.
4. Evaluate the importance of life cycle assessment for pollution prevention and cleaner production awareness plan.
5. To apply the problems related to pollution prevention and cleaner production awareness plan.
6. To choose the green fuels based on their benefits for sustainable development.

Green Technologies and Practices (DJ19MN1C1)		
Unit	**Description**	**Duration**
1	**Introduction to green technology** 1.1 Definition – importance – Historical Evolution – advantages and disadvantages of green technologies. 1.2 Factors affecting green technologies. 1.3 Role of industry, Government and Institutions- Industrial Ecology. Role of Industrial ecology in green technology.	07
2	**Green chemistry** 2.1 Principles of green chemistry, green chemistry metrics- atom economy. 2.2 E factor, reaction mass efficiency. 2.3 Waste: Source of waste, different type of waste.	08

	2.4 Chemical, physical and biochemical methods of waste minimization. 2.5 Clean development Mechanism: reuse, recovery & recycle. 2.6 Raw Material substitution: Wealth from waste, case studies.	
3	**Cleaner production project development and implementation** 3.1 Overview of CP Assessment steps and skills, process flow diagram. 3.2 Material Balance, CP Option Generation: Technical and Environmental Feasibility analysis. 3.3 Economic valuation of alternatives: Total cost Analysis – CP Financing. 3.4 Preparing a program plan: Measuring progress - ISO 14000.	09
4	**Pollution Prevention and cleaner production Awareness Plan** 4.1 Waste audit: Environmental Statement. 4.2 Carbon Credit, Carbon Trading, Carbon footprint. 4.3 Carbon Sequestration. 4.4 Life Cycle Assessment – Elements of LCA. 4.5 Life cycle Costing. 4.6 Eco Labeling.	10
5	**Energy Efficacy.** 5.1 Availability and need of conventional energy resource: major environmental problems related to the conventional energy resources. 5.2 Future possibilities of energy need and availability. 5.3 Non- conventional energy sources: Solar Energy – solar energy conversion technologies and devices. 5.4 Solar Energy: Principles, working and application.	08
6	**Green fuels** 6.1 Definition – benefits and challenges: Comparison of green fuels with conventional fossils fuels with reference to environmental, economic and social impacts – public policies and market driven initiatives. 6.2 Biomass energy: Concept of biomass energy utilization, types if biomass energy., conversion process. 6.3 Wind energy, energy conversion technologies, their principles, equipment and suitability in Indian context. 6.4 Tidal and geothermal energy.	10
	Total	**52**

Books Recommended:

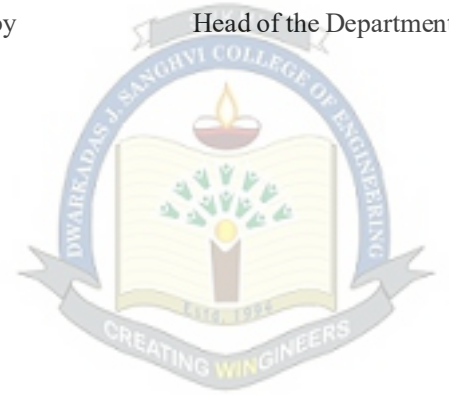
Text books:

1. Paul L Bishop, Pollution Prevention: Fundamentals and practice, McGraw Hill Publications, 2000.
2. World Bank group and UNEP, Washington DC, Pollution Prevention and Abatement Handbook – Towards Cleaner Production, 1998.
3. Prasad Modak, C. Viswanathan and Mandar Parasnis, Cleaner Production Audit, Environmental System reviews, No 38, Asian Institute of Technology, 1995.
4. Bewik M. W. M., Handbook of organic Waste conversion.
5. Sukhatme P. S., Solar Energy

Reference Books:

1. Bokris J. O., Energy, the Solar Hydrogen Alternative.
2. Rai G. D., Non-Conventional Energy Sources.
3. Kiang Y. H., Waste Energy Utilisation Technology.
4. G. D. Rai, Wind, tidal, Geothermal, biomass and Nonconventional Energy Green Fuel.

Prepared by Checked by Head of the Department Principal



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Proposed scheme for Minor in Intelligent Automation and Applied Analytics
(Academic Year 2022-2023)

Sr.	Course Code	Course	Teaching Scheme (hrs.)				Continuous Assessment (A) (marks)			Semester End Assessment (B) (marks)					(A+B)	Total Credits
			Th	P	T	Credits	Th	T/W	Total CA (A)	Th / Cb	O	P	O & P	Total SEA (B)		
Sem V																
1	DJ19MN2C1	Fundamentals of Industrial Automation	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
Sem VI																
2	DJ19MN2C2	Industrial Internet of Thing (IIOT)	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
3	DJ19MN2L1	Industrial Internet of Thing (IIOT)-Lab	--	2	--	1	--	25	25	--	--	--	25	25	50	**1**
Sem VII																
4	DJ19MN2C3	AI and ML for Automation	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
5	DJ19MN2L2	AI and ML for Automation-Lab	--	2	--	1	--	25	25	--	--	--	25	25	50	**1**
Sem VIII																
6	DJ19MN2C4	Applied Predictive Analytics	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
		Total	**16**	**4**	**0**	**18**	**100**	**50**	**150**	**300**	**0**	**0**	**50**	**350**	**500**	**18**

Minor in Intelligent Automation and Applied Analytics **Semester: V**

Program: Common for All Programs (except Electronics Engineering)

Course: Fundamentals of Industrial Automation (DJ19MN2C1)

Pre-requisite: --

1. Basic Electrical & Electronics Engineering

Objectives:

1. To understand & make aware the sensory & actuation environment required for Industry 4.0
2. To make aware various controlling & communication strategies & provide a brief overview of DCS & SCADA systems in Industrial Automation
3. To design basic control systems using PLC architecture & ladder programming

Outcomes: On completion of the course, the learner will be able to:

1. Understand and demonstrate application of sensing and actuation in an industrial environment.
2. Comprehend PLC architecture and implementation of Ladder Programming.
3. Comprehend DCS & SCADA Systems and interpret various industrial communication protocols.

Fundamentals of Industrial Automation (DJ19MN2C1)		
Unit	**Description**	**Duration**
1	**Introduction** Automation in production system, Principles and strategies of automation, Basic elements of an automated system, types of Automation, Hierarchical level in automation, Advanced automation functions, Automated flow lines and transfer mechanisms.	8
2	**Sensors** Introduction to Industrial Measurement; overview of sensors & transducers, classification of sensors - analog, digital, electrical, mechanical; characteristics of sensors, specifications, selection of sensors, basic interfacing and block diagram of instrumentation system. Temperature sensors: Resistance Temperature Detectors Pt100/1000, Ceramic Thermistors-NTC & PTC (Thermistor Bead), Semiconductor PN junction sensors-LM35, Thermopile- MLX 90614, Pyroelectric sensors. Pressure sensors: Concept of Pressure, Semiconductor pressure sensor, Pressure MEMS sensor (HX710B).	8

	Ultrasonic Sensors, Electromagnetic sensors, Resistive Humidity Sensors, Chemical sensors - Taguchi Gas, Combustible Gas, and pH Sensors.	
3	**Actuators** Electrical actuators: Relays, solenoids & electrical motors (DC, AC & stepper motor). Pneumatic actuators: Basic pneumatic system, pneumatic compressors (piston, vane, screw) flapper nozzle, single & double acting cylinder, rotary actuator, filter-regulator-lubricator (FRL). Hydraulic actuator: Hydraulic pumps, control valve types (globe, ball, needle, butterfly, gate, diaphragm & pinch), cavitation & flashing with their remedies.	8
4	**Controller strategy / Automation Tools, PLC** Discrete state process controller: Discrete state variables, process specifications & event sequence description. Relay controller & ladder diagram: Introduction to relay ladder diagram logic, ladder diagram elements & ladder diagram programming examples. PLC: Relay sequencers, programmable logic controller design, PLC operation, programming the PLC, PLC software functions (application examples on relay ladder logic programming).	10
5	**SCADA, DCS & HMI** SCADA: Overview, SCADA Architecture, SCADA-Hardware functions, SCADA applications, case study examples. DCS: Overview and Features of DCS, DCS Architecture, Hardware elements, working of DCS, DCS displays, DCS interfacing with PLC, DCS wiring diagram. HMI: Overview, need, Types, wiring practice, Data Handling, configuration and interfacing with PLC & PC, Communication standards. ASM Graphics.	10
6	**Communication protocols** Overview of sensor networks, ASi interface protocol, CAN, HART, Foundation Fieldbus, Profibus, INTERBUS, M-Bus, Wireless sensor network, Bluetooth, Zigbee, LoRa.	8
	Total	**52**

Books Recommended:

Text books:

1. Curtis D. Johnson, Process Control Instrumentation Technology, 7th edition, PHI
2. Jacob K. Freden, Handbook of Modern sensors, 5th Edition, Springer.
3. S. K. Singh, Industrial Instrumentation & Control, 3rd edition, McGraw Hill.
4. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, IoT Fundamentals Networking Technologies, Protocols, and Use Cases for the Internet of Things CISCO.

Reference Books:

1. Bela G. Liptak, Instrument Engineer's HandBook – Process Measurement and Analysis, ISA CRC Press, 4th Edition, 2003.
2. B.C. Nakra, K. K. Chaudhary, Instrumentation Measurement & Analysis, 3rd edition, McGraw Hill.
3. Andrew Parr, Pneumatics & Hydraulics, 2nd edition, Jaico Publishing Co.
4. Raj Kamal, Internet of Things, Architecture and Design Principles, McGraw Hill Education, Reprint 2018.

Prepared by	Checked by	Head of the Department	Principal
Prof. Darshana Sankhe	Prof. Vivek Nar	Dr. Prasad Joshi	Dr. Hari Vasudevan

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Proposed scheme for Minor in Web Application Development
(Academic Year 2022-2023)

Sr.	Course Code	Course	Teaching Scheme (hrs.)			Continuous Assessment (A) (marks)			Semester End Assessment (B) (marks)					(A+B)	Total Credits
			Th	P	T	Th	T/W	Total CA (A)	Th / Cb	O	P	O & P	Total SEA (B)		
Sem V															
1	DJ19MN3C1	Advanced Java Programming	4	--	--	25	--	**25**	75	--	--	--	**75**	**100**	**4**
Sem VI															
2	DJ19MN3C2	Web Programming	4	--	--	25	--	**25**	75	--	--	--	**75**	**100**	**4**
3	DJ19MN3L1	Web Programming Laboratory	--	2	--	--	25	**25**	--	--	--	25	**25**	**50**	**1**
Sem VII															
4	DJ19MN3C3	Full Stack Development	4	--	--	25	--	**25**	75	--	--	--	**75**	**100**	**4**
5	DJ19MN3L2	Full Stack Development Laboratory	--	2	--	--	25	**25**	--	--	--	25	**25**	**50**	**1**
Sem VIII															
6	DJ19MN3C4	Mobile Application Development	4	--	--	25	--	**25**	75	--	--	--	**75**	**100**	**4**
		Total	**16**	**4**	**0**	**100**	**50**	**150**	**300**	**0**	**0**	**50**	**350**	**500**	**18**

Minor in Web Application Development **Semester: V**

Program: Common to All Programs (except Computer Engineering)

Course: Advanced Java Programming (DJ19MN3C1)

Pre-requisite:

1. Basic Programming
2. Java Programming

Objectives:

1. To enable the students to understand the concepts of advanced Java programming.
2. To enable students to learn to produce well-designed, dynamic Web applications.

Outcomes: On completion of the course, the learner will be able to:

1. Read and make elementary modifications to Java programs that solve real-world problems.
2. Learn to access database through Java programs, using Java Data Base Connectivity (JDBC)
3. Create dynamic web pages, using Servlets and JSP
4. Implement the web-based applications using effective database access with rich client interaction

Advanced Java Programming (DJ19MN3C1)		
Unit	**Description**	**Duration**
1	**Introducing Classes**: Class Fundamentals, Declaring Objects, Assigning Object Reference Variables, Introducing Methods, Constructors, The this Keyword, Garbage Collection, The finalize( ) Method, A Stack Class, A Closer Look at Methods and Classes: Overloading Methods, Using Objects as Parameters, A Closer Look at Argument Passing, Returning Objects, Recursion, Introducing Access Control, Arrays, Inheritance: Inheritance, Using super, Creating a Multilevel Hierarchy, When Constructors Are Called, Method Overriding, Dynamic Method Dispatch, Using Abstract Classes, Using final with Inheritance, The Object Class.	08
2	**Packages and Interfaces**: Packages, Access Protection, Importing Packages, Interfaces, Exception Handling: Exception-Handling Fundamentals, Exception Types, Uncaught Exceptions, Using try and catch, Multiple catch Clauses, Nested try Statements, throw, throws, finally, Java's Built-in Exceptions, Creating Your Own Exception Subclasses, Chained Exceptions, Using Exceptions.	08
3	**Swing**: Need for swing components, Difference between AWT and swing, Components hierarchy, Panes, Swing components: Jlabel, JTextField and JPasswordField, JTextAres, JButton, JCheckBox, JRadioButton, JComboBox and JList	08
4	**JDBC**: Introduction, JDBC Architecture, Types of Drivers, Statement, ResultSet, Read Only ResultSet, Updatable ResultSet, Forward Only ResultSet, Scrollable ResultSet, PreparedStatement, Connection Modes, SavePoint, Batch Updations, Callable Statement, BLOB & CLOB	08

5	**Servlets**: Introduction, Web application Architecture, Http Protocol & Http Methods, Web Server & Web Container, Servlet Interface, GenericServlet, HttpServlet, Servlet Life Cycle, ServletConfig, ServletContext, Servlet Communication, Session Tracking Mechanisms **JSP**: Introduction, JSP LifeCycle, JSP Implicit Objects & Scopes, JSP Directives, JSP Scripting Elements, JSP Actions: Standard actions and customized actions,	10
6	**Java Beans**: Introduction, JavaBeans Properties, Examples Struts 2: Basic MVC Architecture, Struts 2 framework features, Struts 2 MVC pattern, Request life cycle, Examples, Configuration Files, Actions, Interceptors, Results & Result Types, Value Stack/OGNL JSON: Overview, Syntax, DataTypes, Objects, Schema, Comparison with XML, JSON with Java	10
	Total	**52**

Books Recommended:

Text books:

1. Cay S. Horstmann, Gary Cornell, Core Java™ 2: Volume II–Advanced Features Prentice Hall PTR, 9th Edition
2. Herbert Schildt, Java2: The Complete Reference, Tata McGraw-Hill,5th Edition.

Reference Books:

1. Uttam K. Roy, "Advanced Java Programming, Oxford University Press, 2015.
2. D.T. Editorial Services, "Java 8 Programming Black Book", Dreamtech Press, 2015.

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Proposed scheme for Minor in Robotics
(Academic Year 2022-2023)

Sr.	Course Code	Course	Teaching Scheme (hrs.)				Continuous Assessment (A) (marks)			Semester End Assessment (B) (marks)					(A+B)	Total Credits
			Th	P	T	Credits	Th	T/W	Total CA (A)	Th / Cb	O	P	O & P	Total SEA (B)		
Sem V																
1	DJ19MN5C1	Introduction to Robotics	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
Sem VI																
2	DJ19MN5C2	Modelling and Deisgn of Robotics	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
3	DJ19MN5L1	Robotics Laboratory 1	--	2	--	1	--	25	25	--	--	--	25	25	50	**1**
Sem VII																
4	DJ19MN5C3	Advance Robotics	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
5	DJ19MN5L2	Robotics laboratory 2	--	2	--	1	--	25	25	--	--	--	25	25	50	**1**
Sem VIII																
6	DJ19MN5C4	AI and ML for Robotics	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
		Total	**16**	**2**	**0**	**18**	**100**	**50**	**150**	**300**	**0**	**0**	**50**	**325**	**500**	**18**

Minor in Robotics **Semester: V**

Program: Common for All Programs (except Mechanical Engineering)

Course: Introduction to Robotics (DJ19MN5C1)

Pre-requisite:

1. Knowledge of basic elements of mechanical engineering
2. Knowledge of electrical engineering like motors & drives
3. Knowledge of instrumentation related topics like sensors & applications
4. Basic knowledge of control systems engineering

Objectives:

1. To impart knowledge of the fundamental concepts of robotics in the modern-day world from the olden days.
2. Make the student know the anatomical structure of the fixed & mobile robots with actuating systems.
3. To develop the student's knowledge in various types of sensors & its applications.
4. Making the robotic system to know how to do robotic manipulation using different types of end-effectors, viz., the tools & grippers.
5. To introduce the basic principles, techniques, state of art techniques in robot programming with control strategies.
6. Make the learner know about the different types of applications of robots in the modern-day world.

Outcomes: On completion of the course, the learner will be able to:

1. Remember the basic structure of robots with their mathematical interpretations in the 3-dimensional analysis.
2. Understand the kinematic analysis while doing the PNPO.
3. Apply the knowledge of mathematics in developing all possible solutions to the inverse kinematic analysis while doing the PNPO.
4. Analyze the area in which the robot can do the effective PNPO with a well-defined optimized shortest path trajectory.
5. Evaluate the performance of difference learning schemes used for solving a typical robotic application using AI concepts.
6. Create a typical robotic application to solve any type of automated works without human intervention.

Module	Introduction to Robotics - DJ19MEHN1C1	Hours
1	**Introduction to Robotics :** to automation & its types, History & evolution of robotics, Definition of robots, Robotic manipulators, Types of robots,	9

	Generations of robots, Laws of robotics, Classification of robots & its applications, Specifications of robots.	
2	**Robot Anatomy :** Anatomy of robots, Drive systems, Actuators and Power Transmission systems, Types of drives & its applications, Hydraulic drives, Pneumatic drives, Electric drives, Hybrid drives, Robot activation & feedback components.	9
3	**Sensors in robotics :** Touch Sensors, Tactile Sensors, Proximity & Range Sensors, Sensor Based Systems, Force Sensors, Light sensors, Pressure sensors, Ultrasonic sensors, Infra-red sensors, Pots, Encoders, Position & Velocity Sensors.	9
4	**Articulated Mechanical System:** Materials used for robot design & its properties, Transmission devices in robots & its types, End effectors, Types of end effectors, Tools & Grippers, Classification of tools & grippers, Types of tool & gripper actuations.	9
5	**Robot Controllers & Programming :** Robot brain, Controller & its types, Need for controller in robots, Robot simulation, Robot software, Robot Programming & the Languages, Types of robot programming, Industrial robot programming.	8
6	**Robot Applications :** Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defense, Social, Environmental & economic issues in robot applications, Advantages & Disadvantages of Robotization.	8
	Total	52

Books Recommended:

Text books:

1. Dr. T.C.Manjunath, "Fundamentals of Robotics", Nandu Publishers, 5th Edn., India, 2005.
2. Elaine Rich & Kevin Knight, "Artificial Intelligence", Mac Graw Hill, Singapore, 3rd Edn., 2017.
3. Dr. T.C.Manjunath, "Fast Track to Robotics", Nandu Publishers, 2nd Edn., Mumbai, Maharashtra, India, 2005.
4. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, "Robotics: Control Sensing Vision & Intelligence", Mac Graw Hill, USA, 5th Edition, 2010.
5. Robin R. Murphy, "Introduction to AI and Robotics", MIT Press, Second Edition, 648 pp., Oct. 2019.

Reference Books:

1. Industrial Robotics, Technology, Programming & Applications, Grover, Weiss, Nagel, Ordey,Mc Graw Hill.
2. Robotic technology & Flexible Automation, S R Deb. TMH.
3. Robotics for Engineers, Yoram Koren, Mc Graw hill.
4. Fundamentals of Robotics, Larry Health.
5. Robot Analysis & Control, H Asada, JJE Slotine.

6. Robot Technology, Ed. A Pugh, Peter Peregrinus Ltd. IEE, UK. 8. Handbook of Industrial Robotics, Ed. Shimon. John Wiley

7. Roland Siegwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, “Introduction to Autonomous Mobile Robots”, Bradford Company Scituate, US

8. Fundamentals of Robotics – Analysis & Controls, Robert Schilling, Prentice Hall Inc, India.

9. Robotics – Amitaabh Bhattacharya

10. P.A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing company Ltd., 1995.

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Proposed scheme for Minor in Artificail Intelligence and Machine Learning
(Academic Year 2022-2023)

Sr.	Course Code	Course	Teaching Scheme (hrs.)				Continuous Assessment (A) (marks)			Semester End Assessment (B) (marks)					(A+B)	Total Credits
			Th	P	T	Credits	Th	T/W	Total CA (A)	Th / Cb	O	P	O & P	Total SEA (B)		
Sem V																
1	DJ19MN6C1	Artificial Intelligence	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
Sem VI																
2	DJ19MN6C2	Machine Learning	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
3	DJ19MN6L1	Machine Learning Lab	--	2	--	1	--	25	25	--	--	--	25	25	50	**1**
Sem VII																
4	DJ19MN6C3	Deep Learning	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
5	DJ19MN6L2	Deep Learning Lab	--	2	--	1	--	25	25	--	--	--	25	25	50	**1**
Sem VIII																
6	DJ19MN6C4	Natural Language Processing	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
		Total	**16**	**4**	**0**	**18**	**100**	**50**	**150**	**300**	**0**	**0**	**50**	**350**	**500**	**18**

Minor in Artificial Intelligence and Machine Learning **Semester: V**

Program: Common for All Programs (except Information Technology)

Course: Artificial Intelligence (DJ19MN6C1)

Pre-requisite:

1. Knowledge of any programming language
2. Data Structures

Course Objectives:

1. To create thorough understanding of AI basics and real-time applications in its sub-domains.
2. To explores AI techniques like informed, uninformed, and adversarial searching to solve real-life problems in a state space tree representation.
3. Familiarize learner to the advance topics of AI such as planning, handling uncertainty.

Course Outcomes: On completion of the course, the learner will be able to:

1. Understand the basics of artificial intelligence
2. Solve the problem using appropriate AI techniques.

Detailed Syllabus: (unit wise)

Unit	Description	Duration
1	**Introduction:** Definition, Future of Artificial Intelligence, Characteristics of Intelligent Agents, Typical Intelligent Agents, Problem Solving Approach to Typical AI problems **Intelligent Systems**: Introduction to AI, Components of AI, AI Problems and AI Techniques, solving problems by searching, Problem Formulation, State Space Representation. **Intelligent Agents:** Structure of Intelligent agents, Types of Agents, Agent Environments PEAS representation for an Agent.	**08**
2	**Problem solving Methods:** Types: Uninformed, Informed - Heuristics based. **Uninformed Search**: DFS, BFS, Uniform cost search, Depth Limited Search, Iterative Deepening. **Informed Search**: Heuristic functions, Best First Search, A* algorithm **Local Search Algorithms** and Optimization Problems - Hill Climbing, Simulated Annealing Searching with Partial Observations **Constraint Satisfaction Problems**: Crypto Arithmetic, Map Coloring, N-Queens, Backtracking Search **Adversarial Search**: Game Playing, Min-Max Search, Alpha Beta Pruning	**12**
3	**Knowledge Representation and Inference**: A Knowledge Based Agent, Knowledge representation technique: Logical Representation, Semantic Network Representation Frame Representation, Production Rules. Overview of Propositional Logic, First Order Predicate Logic, Inference in First Order Predicate Logic: Forward and Backward Chaining, Resolution.	**12**

4	**Uncertain Knowledge and Reasoning**: Uncertainty, Representing Knowledge in an Uncertain Domain, Conditional Probability, Joint Probability, Bayes' theorem, Belief Networks, Simple Inference in Belief Networks.	**08**
5	**Theory of Learning**: Types (Supervised Learning, Unsupervised Learning, Reinforcement learning), PAC learning. Introduction to statistical learning, Learning from Rewards, Passive Reinforcement Learning, Active reinforcement Learning	**06**
6	**Applications of AI**: AI Domains: NLP, ML, Deep Learning, Data Science, Cognitive Science. **Introduction to Expert Systems**- Definition, Characteristics, architecture, Knowledge Engineering, Building Expert Systems. Methodologies for building expert systems: knowledge acquisition and elicitation; formalization; representation and evaluation. Knowledge Engineering tools.	**06**

Books Recommended:

Text Books:

1. Elaine Rich and Kevin Knight, "Artificial Intelligence", Third Edition, McGraw Hill Education, 2017.
2. Stuart J. Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition" Pearson Education, 2021.
3. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication, July 2017.

Reference Books:

1. Saroj Kaushik, "Artificial Intelligence", Cengage Learning, First edition, 2011
2. George F Luger, "Artificial Intelligence: Structures and Strategies for Complex Problem Solving", Sixth edition, Pearson Education,2009.

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Proposed scheme for Minor in Electric Vehicles
(Academic Year 2022-2023)

Sr.	Course Code	Course	Teaching Scheme (hrs.)				Continuous Assessment (A) (marks)			Semester End Assessment (B) (marks)					(A+B)	Total Credits
			Th	P	T	Credits	Th	T/W	Total CA (A)	Th / Cb	O	P	O & P	Total SEA (B)		
Sem V																
1	DJ19MN7C1	Fundamentals of Electric Vehicles	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
Sem VI																
2	DJ19MN7C2	Electric drives and controls	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
3	DJ19MN7L1	Electric Vehicle Laboratory 1		2		1	0	25	25	--	--	--	25	25	50	**1**
Sem VII																
4	DJ19MN7C3	Energy source management	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
5	DJ19MN7L2	Electric Vehicle Laboratory 2	--	2	--	1	--	25	25	--	--	--	25	25	50	**1**
Sem VIII																
6	DJ19MN7C4	Electric Vehicle System Design	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
		Total	**16**	**4**	**0**	**18**	**100**	**25**	**125**	**300**	**0**	**0**	**25**	**325**	**500**	**18**

Minor in Electric Vehicles **Semester: V**

Program: Common for All Programs (except Mechanical Engineering)

Course: Fundamentals of Electric Vehicles (DJ19MN7C1)

Pre-requisite:

1.Basic of electronics and electrical engineering
2.fundamentals of physics and engineering mechanics

Objectives:

1. To study different automotive components and subsystems
2. To explore the transition of automotive domain from Internal Combustion Engine to electric vehicles

Outcomes: On completion of the course, the learner will be able to:

1 To explain the basic of Electric vehicles and its major parts.
2. To define the functionality and working principles of different types of Automotive Powertrains
3. To illustrate the working of various automotive transmission systems
4. To explain vehicle fundamentals of various subsystem.
5. To illustrate the working of motors and conversions.
6. To identify and illustrate the various hybrid electric powertrains and their different modes of operations

Electric Vehicles (DJ19MEHN1C1)		
Unit	**Description**	**Duration**
1	**Electric Vehicles** History, Basics of Electric Vehicles ,Components of Electric Vehicle, General Layout of EV, EV classification : Battery Electric Vehicles (BEVs), Fuel-Cell Electric Vehicles (FCEVs) Comparison with Internal Combustion Engine: Technology, Advantages & Disadvantages of EV, National Policy for adoption of EVs, Overview of Tesla car.	10
2	**Vehicle Mechanics** History of Vehicle Development, General Configuration of Automobile, Body and Chassis Fundamentals: General Packaging, Types of Structural System, Backbone Construction; Body and Chassis Materials. Automotive Powertrain Mechanical, Suspensions system, Steering System, NVH, Control System Integration and Implementation. Front-Wheel Drive (FWD) Powertrains, Rear-Wheel Drive Powertrains (RWD), Multi-Wheel Drive Powertrains (AWD and 4WD).	10
3	**Transmission Systems** Transmission gears, Manual Transmission (MT), Automatic Transmission (AT), Automated Manual Transmissions (AMT) and Continuously Variable Transmissions (CVT); Manual Transmissions Powertrain Layout and Manual Transmission Structure, Power Flows and Gear Ratios, Manual Transmission Clutch and its structure. Drivetrain and Differential.	10

4	**Vehicle fundamentals** Vehicle resistance, Types: Rolling Resistance, grading resistance, Aerodynamic drag vehicle performance, Calculating The Acceleration Force, maximum speed, Finding The Total Tractive Effort, Torque Required On The Drive Wheel, Transmission: Differential, clutch &gear box, Braking performance.	10
5	**Conversions and motors** Introduction of DC-DC, AC-AC ,AC-DC,DC-AC, four-quadrant operation, Driver circuits. Principle and working of DC motor, Characteristics and Types of DC Motors- Overview (Speed torque characteristics) of Permanent Magnet motor, BLDC Motor, Induction motor. Comparison of all motors.	6
6	**Hybrid Powertrain**: Series HEVs, Parallel HEVs, Series–Parallel HEVs, Complex HEVs, Operating Modes, Degree of Hybridization, Comparison of HEVs, Plug-in Hybrid Electric Vehicles (PHEVs) Real Life examples of HEVs, compare and contrast the performance of ICE vehicles, HEVs and EVs.	**6**
	Total	**52**

Books Recommended:

Text books:

1. Vehicle Powertrain Systems by Behrooz Mashadi and David Crolla, Wiley, 2012
2. Automotive Aerodynamics by Joseph Katz, Wiley, 2016
3. Automotive Chassis Engineering, by David C. Barton and John D. Fieldhouse, Springer, 2018
4. Automotive Engineering Powertrain, Chassis System and Vehicle Body Edited by David A. Crolla, Elsevier,2009
5. Automotive Power Transmission Systems by Yi Zhang and Chris Mi, Wiley, 2018
6. Linear Electric Machines, Drives, and MAGLEVs Handbook, by Ion Boldea, CRC Press. 2013
7. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles by Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, and Ali Emadi, CRC Press 2005
8. Electric Vehicle Technology Explained by James Larminie and John Lowry, John Wiley, 2003
9. Electric and Hybrid Vehicles- Design Fundamentals by Iqbal Husain, CRC Press, 2005

Reference Books:

1. Encyclopaedia of Automotive Engineering edited by David Crolla et al, Wiley, 2014
2. Design and Control of Automotive Propulsion Systems by Zongxuan Sun and Guoming Zhu, CRC Press, 2015
3. The Automotive Transmission Book by Robert Fischer, Ferit Küçükay, Gunter Jürgens, Rolf Najork, and
4. Burkhard Pollak, Springer, 2015
5. Noise and Vibration Control in Automotive Bodies by Jian Pang, Wiley, 2019

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Proposed scheme for Minor in IoT and Industry 4.0
(Academic Year 2022-2023)

Sr.	Course Code	Course	Teaching Scheme (hrs.)				Continuous Assessment (A) (marks)			Semester End Assessment (B) (marks)					(A+B)	Total Credits
			Th	P	T	Credits	Th	T/W	Total CA (A)	Th / Cb	O	P	O & P	Total SEA (B)		
Sem V																
1	DJ19MN8C1	Sensor Technology	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
Sem VI																
2	DJ19MN8C2	IoT System Design	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
Sem VII																
3	DJ19MN8C3	IoT Network Design	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
4	DJ19MN8L1	IoT System and Network Design Laboratory	--	2	--	1	--	25	25	--	--	--	25	25	50	**1**
Sem VIII																
5	DJ19MN8C4	Industry 4.0	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
5	DJ19MN8L2	Industry 4.0 Laboratory	--	2	--	1	--	25	25	--	--	--	25	25	50	**1**
		Total	**16**	**4**	**0**	**18**	**100**	**50**	**150**	**300**	**0**	**0**	**50**	**350**	**500**	**18**

Minor in IoT and Industry 4.0 **Semester: V**

Program: Common for All Programs (except Electronics & Telecommunication Engineering)

Course: Sensor Technology (DJ19MN8C1)

Pre-requisite: --

1. Basics of Electrical and Electronics Engineering

Objectives:

1. To provide understanding of physical parameters and sensing techniques of various sensors.
2. To provide Understanding about signal conditioning principle.
3. To familiarize about MEMS sensors and actuators.

Outcomes: On completion of the course, the learner will be able to:

1. To understand the transduction principle of various sensors
2. To select sensors suitable for required application
3. To analyze wireless sensing technique
4. To design data acquisition system.
5. Identify signal conditioning method for particular application

IoT and Industry 4.0 (DJ19MN8C1)		
Unit	**Description**	**Duration**
1	**Classification and Performance Characteristics of Sensors and Actuators:** Classification of Sensors and Actuators: General Requirements for Interfacing, Units and Measures, Transfer function, Impedance and Impedance matching, Range, Span, Resolution, Accuracy, Errors, Repeatability, Sensitivity and Sensitivity analysis, Hysteresis, Nonlinearity and saturation, Frequency Response, Response Time and Bandwidth, Calibration, Excitation, Deadband, Reliability.	10
2	**Temperature and Optical Sensors and Actuators:** Thermo resistive Sensors: Thermistors, Resistance temperature sensors, Silicon resistive sensors, Thermoelectric sensors, PN Junction Temperature sensors, Optical and Acoustical sensors, Thermo mechanical sensors and Actuators. Optical Sensors and Actuators: Effects of Optical Radiation, Quantum Based Optical sensors, Photoelectric sensors, Coupled Charge (CCD) sensors and Detectors, Thermal Based Optical sensors, Optical Actuators.	10
3	**Electric, Magnetic, Mechanical Sensors and Actuators:** Electric Field: Capacitive Sensors and Actuators Magnetic Field: Inductive sensors and Hall effect sensors, Sensors and Actuators, Magnetometers Magnetic Actuators, Voltage and Current sensors.	10

	Mechanical sensors and Actuators, Radiation sensors, Accelerometers, Pressure sensors, Gyroscopes.	
4	**Signal Conditioning:** Fundamentals of data Acquisition: Analog and Digital Data acquisition system with different configurations, data loggers, noise and interference. Signal Conditioning: Wheatstone bridge, Flash ADC, R2R DAC. Utilization of Signal Conditioning circuits for Temperature, Pressure, Optical, Strain Gauges, Displacement and Piezoelectric transducers.	06
5	**Current Trends in sensors:** Introduction, Primary sensors, Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing, Data Communication, Standards for Smart sensor interface, The Automation Sensor Technologies: Introduction, Film Sensors, Thick Film Sensors, Thin Film sensors, Semiconductor IC Technology Standard Methods, Microelectromechanical Systems (MEMS), Nano-sensors Sensor Applications: On-board Automobile sensors, Home appliances sensors, Aerospace sensors, Sensors for Environmental Monitoring Self-learning Topics: Energy Harvesting, Self-powered Wireless Sensing in ground, Ground penetrating sensors.	10
	Total	**46**

Books Recommended:

Text books:

1. D. Patranabis, *Sensor and Actuators*, 2nd Edition, Prentice Hall of India.
2. A. K. Sawhney, *A course in Electronic Measurements and Instrumentation,*19th Edition, Dhanpat Rai & Co.
3. H. S. Kalsi, *Electronic Instrumentation and Measurements,*4th Edition, McGraw-Hill.
4. Nathan Ida, *Sensors, Actuators and their Interfaces,* SciTech Publishing,2013.

Reference Books:

1. Clarence. W. de Silva, *Sensors and Actuators: Engineering System Instrumentation,* 2nd Edition, CRC Press, 2015.
2. Ernest. O. Doebelin, *Measurement Systems, Application and design,* Tata McGraw- Hill, Publishing Company Ltd., 5th Edition, 2004.
3. D. A. Bradley, D. Dawson, N. C. Burd, A. J. Loader, *Mechatronics*, Thomson Press India Ltd., 2004.
4. S. Renganathan, *Transducer Engineering,* Allied Publishers (P) Ltd., 2003.
5. W. Bolton, Mechatronics, 4th Edition, Pearson Education, 2011.

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Proposed scheme for Minor in Data Science

(Academic Year 2022-2023)

Sr.	Course Code	Course	Teaching Scheme (hrs.)				Continuous Assessment (A) (marks)			Semester End Assessment (B) (marks)					(A+B)	Total Credits
			Th	P	T	Credits	Th	T/W	Total CA (A)	Th / Cb	O	P	O & P	Total SEA (B)		
Sem V																
1	DJ19MN4C1	Foundations of Data Analysis	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
Sem VI																
2	DJ19MN4C2	Machine Learning	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
	DJ19MN4L1	Machine Learning Laboratory	--	2	--	1	--	25	25	--	--	--	--	25	25	**1**
Sem VII																
3	DJ19MN4C3	Advanced Machine Learning	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
4	DJ19MN4L2	Advanced Machine Learning Laboratory	--	2	--	1	--	25	25	--	--	--	--	25	25	**1**
Sem VIII																
5	DJ19MN4C4	Big Data Engineering	4	--	--	4	25	--	25	75	--	--	--	75	100	**4**
		Total	**16**	**4**	**0**	**18**	**100**	**50**	**150**	**300**	**0**	**0**	**--**	**350**	**450**	**18**

Minor in Data Science **Semester: V**

Program: Common for All Programs (except Computer Science and Engineering (Data Science)

Course: Foundations of Data Analysis (DJ19MN4C1)

Pre-requisite:

1. Basic Mathematics

Objectives:

1. To develop skills of data analysis techniques for data modelling.

Outcomes: On completion of the course, the learner will be able to:

1. Apply visualization techniques to understand Data.
2. Apply ETL and perform OLAP operation.
3. Use descriptive statistics to analyses data.
4. Perform various techniques to improve quality of data.
5. Apply appropriate feature engineering technique to prepare data for modelling.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1.	**Data Warehouse, ETL and OLAP:** Data cube: multidimensional data model, star, snowflake and fact consolidation, dimension and measures, Major steps in ETL process, Data extraction, Data transformation, Data Loading, OLTP Vs OLAP, OLAP definition Dimensional Analysis, Hypercube, OLAP operations: Drill down, Roll up, Slice, Dice and Rotation, OLAP models: MOLAP, ROLAP.	**12**
2.	**Data visualization:** Data visualization process, importance of data visualization, types of data: quantitative (numeric), qualitative (categorical), principles for data visualization, Temporal: Scatter plots, Time Series sequences, Line graphs; Hierarchal: Tree diagrams, Ring charts; Network: Matrix charts, Node-link diagrams, Word clouds, Alluvial diagrams; Multidimensional: Pie chart, Venn diagrams, Stacked bar graph, Histograms; Geospatial: Flow map, Density map, Heat maps, data Visualization using Tableau, Dashboards, storytelling.	**10**
3.	**Descriptive Statistics:** Types of statistics, population vs sample Measures of Central Tendency: arithmetic mean, properties, weighted mean, properties, median, mode, grouped and ungrouped data, empirical relation between the mean, median and mode, geometric mean, harmonic mean, relation between arithmetic, geometric and harmonic mean, outlier. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, properties, variance, root mean square deviation, empirical relations between measures of dispersion, absolute and relative dispersion, coefficient of variation, moments, Pearson's β and γ coefficients, skewness, kurtosis, population parameters and sample statistics, histogram, frequency polygon Measures of position: quartiles, interquartile range, semi interquartile range, percentiles, percentile rank, 10–90 percentile range, box and whisker plot	**08**

4.	**Data Preprocessing** Data Quality: measurement error, data collection error, noise, artifacts, precision, bias, accuracy, outliers, missing values, inconsistent values, duplicate values Data Cleaning: handling missing values and noisy data Data Transformation: smoothing, attribute construction, aggregation, normalization; Data Discretization: binning, histogram analysis, cluster Outlier detection: types of outliers, challenges, statistical method, proximity-based method, clustering-based method	**10**
5.	**Examining Relationship** Correlation: Scatter plot, covariance, Karl Pearson's coefficient of correlation, hypothesis test for correlation, correlation vs causation, extreme data values, limits of correlation coefficient, Rank correlation, Spearman's rank correlation coefficient, Repeated ranks, partial and multi correlation	**04**
6.	**Feature Engineering** Curse of Dimensionality, Feature selection: Univariate methods (Pearson correlation, F score, Chi-square, Signal to noise ratio) and Multivariate methods (Forward selection, backward selection and stepwise selection). Feature Transformation using PCA.	**08**

Books Recommended:

Text books:

1. Data Preparation for Machine Learning, Jason Browniee, ebook by Machine Learning Mastry. Best Practices in Data Cleaning: A Complete Guide to Everything you Need to Do Before and After Collecting Your Data, Jason Osborne, Sage Publication, 2012.
2. Feature Engineering and Selection: A practical Approach for Predictive Models, Max Kuhn and Keijell Statistical Methods, S. P. Gupta, Sultan Chand, 2014, forty third edition
3. Think Stats: Probability and Statistics for Programmers, Allen B. Downey, Green Tea Press, 2011 Johnson, CRC Press, 2020.

Reference Books:

1. The Big Book of Dashboards: Visualizing your Data using Readl-World Business Scenarios, Jeffrey Shaffer, Steve Wexier, Andy Cotgreave, and Wiley 2017.
2. Bad Data Handbook: Cleaning Up the Data so you can get back to work, Ethan McCallum, O'Reilly, 2012.
3. Fundamentals of mathematical statistics, S.C.Gupta and V.K.Kapoor, second edition, Sultan Chand Publisher.
4. Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals, Paulraj Ponniah, Wiley, Second Edition, Practical Tableau, Rayan Sleeper, O'Reilly 2018.
5. Data Mining Concepts and Techniques, Han, Kamber, Morgan Kaufmann 3nd Edition.
6. Python for Data Analysis, Wes McKinney, O'Reilly, Second Edition, 2018.

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