Sri SAI RAM ENGINEERING COLLEGE

An Autonomous Institution

Affiliated to Anna University & Approved by AICTE, New Delhi

OPEN ELECTIVES

I - VIII SEMESTER
AUTONOMOUS CURRICULA AND SYLLABI
Regulations 2020

B.E. DEPARTMENT OF MECHANICAL AND AUTOMATION ENGINEERING

S. NO	COURSE CODE	COURSE TITLE	CONTACT HOURS	WEEK HOURS			CREDITS
				L	T	P	C
1	20MUOE901	Introduction to Digital Manufacturing	3	0	0	3	3
2	20MUOE902	Sustainable Manufacturing Systems	3	0	0	3	3
3	20MUOE903	Introduction to Robotics	3	0	0	3	3
4	20MUOE904	Disaster Management	3	0	0	3	3
5	20MUOE905	Industrial safety Engineering	3	0	0	3	3
6	20MUOE906	Introduction to Industrial Automation	3	0	0	3	3
7	20MUOE907	Applications of 3D Printing Techniques	3	0	0	3	3
8	20MUOE908	Introduction to Industrial Engineering	3	0	0	3	3
9	20MUOE909	Introduction to CNC systems	3	0	0	3	3
10	20MUOE910	Principles of Sustainable Design and Production	3	0	0	3	3

OPEN ELECTIVES

20MUOE901 SDG NO. 3,4,8,9,11	INTRODUCTION TO DIGITAL MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To acquire knowledge on the integrated use of automated system, processes and tools in design and manufacturing

UNIT I AN OVERVIEW **9**

Digital Manufacturing- CAD, CAD Software, CAM, CAE, CAPP, Factory layout planning, Ergonomics, offline robot programming, Production process simulation, PLM systems, Drivers for a digital transformation.

UNIT II INDUSTRY 4.0 **9**

The pace of technological change, Industry 4.0 – definition, components, characteristics, design principles, the building blocks of Industry 4.0, value chain, Today's factory Vs Industry 4.0, Government initiatives.

UNIT III TECHNOLOGY ROADMAP **7**

Introduction, Proposed Framework for Technology Roadmap, Strategy Phase, New Product and Process Development Phase.

UNIT IV EMERGING TECHNOLOGIES **11**

Emerging technologies and trends in the industry – Additive manufacturing technologies, self-configuration and self-diagnosis methods based on internet of things technologies, Artificial intelligence for manufacturing process. Big data analytics for reconfigurable manufacturing systems, Augmented realty, Virtual reality and collaborative robots and their role in production, design and logistics.

UNIT V FUTURE OF DIGITAL MANUFACTURING **9**

Smart supply chains – control algorithms for smart part logistic, Digital Transformation challenges. New and Successful business models in the industry. Additional resources and external organizations that can support on digital manufacturing needs.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. 1. Zude Zhou, Shane (Shengquan) Xie, Dejun Chen, Fundemendals of Digital Manufacturing Science, Springer-Verlag Londan Ltd, 2012
2. Alp Ustundag, Emre Cevikcan, Industry 4.0: Managing the Digital Transformation, Springer Series in Advanced Manufacturing, Springer, 2018.

REFERENCES

1. Christoph Haag, Torsten Niechoj, Digital Manufacturing: Prospects and Challenges, Metropolis Verlag, 2016.
2. Kaushik Kumar, Divya Zindani, J.Paulo Davim, Digital Manufacturng Assembly Systems in Industry 4.0, CRC Press, 2019.
3. Asterios Agkathidis, Digital Manufacturing in Design and Architecture, BIS Publishers, 2011.
4. Wang, Lihui, Nee, Andrew Yeh Ching (Eds.), Collaborative Design and Planning for Digital Manufacturing, Springer, 2009.
5. Bartodziej, Christoph Jan,"The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics", Springer, 2017

WEB RESOURCES:

1. https://www.scribd.com/document/384152232/Digital-Manufacturing#
2. https://www.studocu.com/in/document/apj-abdul-kalam-technological-university/machine-tools-and-digital-manufacturing/module-6-lecture-notes-machine-tools-and-digital-manufacturing/24070532.

ONLINE RESOURCES:

1. https://www.youtube.com/

OUTCOMES:

Upon completion of the course, the students should be able to:

1. Articulate the meaning of Digital Manufacturing, the possibility to extend to the industry and the availability of tools and technologies for industrial revolution.(K1)
2. Identify the technological change and future of Industry 4.0.(K2)
3. Describe the conceptual framework and roadmap of Industry 4.0(K2)
4. Identify the factors in selecting technologies and implementing Digital Manufacturing.(K2)

5. Identify the supply chain, challenges in digital transformation, and business models in the industry.(K2)

CO - PO, PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	1	-	1	2	2	1	2	2	2	2	-	1
CO2	-	-	-	-	1	2	2	1	2	2	2	2	1	1
CO3	-	-	-	-	1	1	1	2	2	2	1	2	1	2
CO4	-	-	-	-	2	1	1	1	1	-	2	2	1	2
CO5	-	-	-	-	2	2	2	2	2	2	2	2	1	2

20MUOE902 SDG NO. 4,9,11	SUSTAINABLE MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the various concepts associated with Manufacturing and Design for sustainability.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLANGES 9

Definition of sustainability – Environmental, Economical and Social dimensions of sustainability - Sustainable Development Models – Strong and Weak Sustainability – Defining Development- Millennium Development Goals – Mindsets for Sustainability : Earthly, Analytical, Precautionary, Action and Collaborative– Syndromes of Global Change: Utilisation Syndromes, Development Syndromes, and Sink Syndromes – Core problems and Cross Cutting Issues of the 21 Century - Global, Regional and Local environmental issues – Social insecurity - Resource Degradation – Climate Change – Desertification, Case Studies

UNIT II PRINCIPLES AND FRAME WORK 9

History and emergence of the concept of sustainable development - Our Common Future - Stockholm to Rio plus 20– Rio Principles of Sustainable Development – 6 R Concept, Precautionary Principle- Polluter Pays Principle – Role of Civil Society, Business and Government -Natural Step- Peoples Earth Charter – Business Charter for Sustainable Development –UN Global Compact – Agenda ,Product Design for Sustainability

UNIT III SUSTAINABILE LIVELI HOOD **9**

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution – Combating Poverty, -Millennium Development Goals, Indicators, Targets, Status and intervention areas - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS **10**

Protecting and Promoting Human Health – Investing in Natural Capital-Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation -Biodiversity conservation and Ecosystem integrity – Urbanization and Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation – Sustainable Consumption and Production – Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms.

UNIT V ASSESSING PROGRESS AND WAY FORWARD **8**

Sustainability in global, regional and national context – Rio Plus 20 - Measuring Sustainability –limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development -Hurdles to Sustainability – Operational guidelines –-Science and Technology for sustainable development – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning – Governance - Science and Technology- Sustainability Education

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Sustainable Manufacturing-Paulo Davim, Wiley Publishers,1st Edition, 2010
2. Sustainable Manufacturing-Challenges, Solutions and Implementation Perspectives, Springer Open Access,Strak,Rainer,Seliger,Gunther,2017

REFERENCES

1. Sayer, J. and Campbell, B., The Science of Sustainable Development : Local Livelihoods and the Global Environment (Biological Conservation, Restoration &Sustainability), Cambridge University Press, London, 2003.
2. Kirkby, J., O Keefe, P. and Timberlake, Sustainable Development, Earthscan Publication, London,1993.

3. TERI New Delhi, Sustainable Development in India – stocktaking in the Run up to Rio plus 20,Ministry of Environment and forests,2011
4. United Nations Report , Indicators of Sustainable Development: Guidelines and Methodologies. New York: United Nations.,3rd Edition,2007
5. United Nations Energy Program, Towards a Green Economy: Pathways to Sustainable Development and Poverty, 2011

WEB RESOURCES:

1. https://www.futurelearn.com/courses/exploring-sustainable-production-systems
2. https://www.precog.co/glossary/sustainable-manufacturing/
3. https://www.nist.gov/blogs/taking-measure/sustainable-manufacturing-smart-manufacturing

ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_mg85/preview

OUTCOMES:

Upon completion of the course, the students should be able to:

1. Understand the basics of Sustainability(K1)
2. Explain the History and current status of Sustainability(K2)
3. Explain various Sustainable livelihood(K2)
4. Describe the practical ways of following the sustainability concept.(K2)
5. Enumerate the indices of Sustainable Progress.(K2)

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	1	1	2	1	2	1	2	2	1	2
CO2	-	-	-	-	1	1	2	2	2	1	2	2	1	2
CO3	-	-	-	-	2	1	2	1	2	1	1	2	1	2
CO4	-	-	-	-	1	1	2	2	2	1	2	2	1	2
CO5	-	-	-	-	2	1	2	1	2	1	1	2	1	2

20MUOE903 SDG NO. 4, 9, 12, 17	INTRODUCTION TO ROBOTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Identify robots and its peripherals for satisfactory operation and control of robots for industrial and non-industrial applications.
- Understand how the different subsystems in a robot work individually and together.
- Organize the work while you design of a large, complex system.

UNIT I INTRODUCTION **9**

Robot-Basic concepts, Need, Law, History, Anatomy, specifications. Robot configurations - cartesian, cylinder, polar and articulate. Robot wrist mechanism, Precision and accuracy of robot.

UNIT II ROBOT ELEMENTS **9**

End effectors-Classification, Types of Mechanical actuation, Gripper design, Robot drive system Types, Position and velocity feedback devices-Robot joints and links-Types, Motion interpolation.

UNIT III ROBOT KINEMATICS AND CONTROL **9**

Robot kinematics – Basics of direct and inverse kinematics, Robot trajectories, 2D and 3D Transformation-Scaling, Rotation, Translation Homogeneous transformation. Control of robot manipulators – Point to point, Continuous Path Control, Robot programming.

UNIT IV SENSORS IN ROBOTICS **9**

Sensors in robot – Touch sensors-Tactile sensor – Proximity and range sensors. Force sensor-Light sensors, Pressure sensors, fail safe hazard sensor systems and compliance mechanism. Introduction to Machine Vision.

UNIT V ROBOT APPLICATIONS **9**

Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defence, Disaster management. Applications, Micro and Nanorobots, Future Applications.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Mikell P. Groover, Mitchell Weiss, Roger N Nagel, Nicholas G Odrey, "Industrial Robotics Technology, Programming and Applications", Tata –McGraw Hill Pub. Co., 2008.

2. Deb.S.R and Sankha Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing Company Limited, 2010.

REFERENCES

1. Fu.K.S, Gonzalez.R.C&Lee.C.S.G, "Robotics control, sensing, vision and intelligence", Tata- McGraw Hill Pub. Co., 2008
2. R.D.Klafter,T.A.Chimielewski and M.Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India, New Delhi, 1994.
3. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi, 4th Reprint, 2005.
4. JohnJ.Craig , Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.
5. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.

WEB RESOURCES:

1. https://www.coursera.org/specializations/robotics
2. https://www.coursera.org/specializations/modernrobotics
3. https://www.coursera.org/specializations/roboticprocessautomation
4. https://www.edx.org/learn/robotics

ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_me76/preview
2. https://onlinecourses.nptel.ac.in/noc22_de11/preview
3. https://nptel.ac.in/courses/112105249
4. https://onlinecourses.nptel.ac.in/noc23_me51/preview

OUTCOMES:

Upon completion of the course, the students should be able to:

1. Understand basic concept of robotics.(K1)
2. Explain the basic elements of industrial robots(K2)
3. Analyze robot kinematics and its control methods(K3)
4. Classify the various sensors used in robots for better performance.(K2)
5. Summarize various industrial and non-industrial applications of robots.(K2)

CO – PO, PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	1	-	1	-	-	2	1	1
CO2	-	-	-	-	-	-	-	1	-	-	-	1	-	1
CO3	1	1	1	1	2	-	1	1	1	-	-	2	2	1
CO4	1	-	-	-	2	-	2	-	-	-	-	2	2	2
CO5	-	-	-	-	2	2	2	2	2	2	2	2	2	2

20MUOE904 SDG NO. 4,9,13	DISASTER MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Provide students an exposure to disasters, their significance and types.
- Ensure that students begin to understand the relationship between Vulnerability, Disasters, Disaster prevention and risk reduction.
- Study a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- Enhance awareness of institutional processes in the country.
- Develop rudimentary ability to respond to their surroundings with potential Disaster response in areas where they live, with due sensitivity

UNIT I INTRODUCTION TO DISASTERS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, Class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, Complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR) 9

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders-

Institutional Processes and Framework at State and Central Level- State Disaster Management Authority (SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT 9

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, Embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous Knowledge, appropriate technology and Local resources.

UNIT IV DISASTER RISK MANAGEMENT IN INDIA 9

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmers And legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011
2. Singhal J.P. "Disaster Management", Laxmi Publications, 2010.

REFERENCES:

1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2002.
2. Government of India, National Disaster Management Policy, 2009.
3. KapurAnu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage, Publishers, New Delhi, 2010.

4. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012.

WEB RESOURCES:

1. https://www.careers360.com/university/school-of-planning-and-architecture-delhi/urban-disaster-risk-mitigation-and-climate-resilient-development-certification-course
2. https://www.ready.gov/be-informed
3. https://nidm.gov.in/research.asp
4. //efaidnbmnnnibpcajpcglclefindmkaj/https://egyankosh.ac.in/bitstream/123456789/56158/1/B-4U-15.pdf

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/105104183
2. https://onlinecourses.nptel.ac.in/noc22_ar05/preview
3. https://www.digimat.in/nptel/courses/video/124107007/L35.html

OUTCOMES:

Upon completion of the course, the students should be able to:

1. Differentiate the types of disasters, causes and their impact on environment and Society (K2)
2. Assess vulnerability and various methods of risk reduction measures as well as Mitigation. (K2)
3. Draw the hazard and vulnerability profile of India, Scenarios in the Indian context. Know the Disaster damage assessment and management. (K2)
4. Awareness of institutional processes in the country and to develop rudimentary (K2)
5. Ability to respond to their surroundings with potential disaster response in areas where they live. (K2)

CO – PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	1	2	2	1	3	2	-	1	-	2
CO2	-	-	-	-	2	2	3	2	2	-	-	2	-	2
CO3	-	-	-	-	2	3	3	2	2	-	-	2	-	2
CO4	-	-	-	-	-	3	3	2	2	-	-	2	-	2
CO5	-	-	-	-	-	3	3	2	2	-	-	2	-	2

20MUOE905 SDG NO. 3,4,9,12	INDUSTRIAL SAFETY ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To Understand the Introduction and basic Terminologies safety.
- To enable the students to learn about the Important Statutory Regulations and standards.
- To enable students to Conduct and participate the various Safety activities in the Industry.
- To have knowledge about Workplace Exposures and Hazards.
- To assess the various Hazards and consequences through various Risk Assessment Techniques

UNIT I SAFETY TERMINOLOGIES 9

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold Limit Value (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects- Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS.

UNIT II STANDARDS AND REGULATIONS 9

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006.

UNIT III SAFETY ACTIVITIES 9

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment.

UNIT IV WORKPLACE HEALTH AND SAFETY 9

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety Toxic gas Release.

UNIT V HAZARD IDENTIFICATION TECHNIQUES 9

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems Khanna Publisher, 2000.
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education, 2005.

REFERENCES:

1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries. Butterworth-Heinemann publications, UK, 4th Edition, 2012.
2. John Ridley & John Channing ,"Safety at Work: Routledge", 7th Edition, 2008.
3. Dan Petersen, "Techniques of Safety Management: A System Approach", 2003.
4. Alan Waring, "Safety management system", Chapman & Hall, England Society of Safety Engineers, USA, 1996.

WEB RESOURCES:

1. https://www.classcentral.com/course/swayam-industrial-safety-engineering-14124
2. https://www.ilo.org/global/topics/safety-and-health-at-work/resources-library/training/lang--en/index.htm
3. https://www.osha.gov/training/library/materials
4. https://www.iso.org/standard/63787.html
5. https://law.resource.org/pub/in/bis/S02/is.14489.1998.pdf
6. https://law.resource.org/pub/in/bis/S02/is.15656.2006.pdf

ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc20_mg43/preview
2. https://onlinecourses.nptel.ac.in/noc22_ch45/preview

OUTCOMES:

Upon completion of the course, the students should be able to:

1. Understand the basic concept of safety. (K1)
2. Obtain knowledge of Statutory Regulations and standards.(K2)

3. Know about the safety Activities of the Working Place.(K2)
4. Analyze on the impact of Occupational Exposures and their Remedies(K2)
5. Obtain knowledge of Risk Assessment Techniques(K2)

CO – PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	2	2	2	2	1	1	-	2	1	2
CO2	1	-	-	-	2	2	2	2	1	1	-	2	1	2
CO3	1	-	-	-	2	2	2	2	1	1	-	2	1	2
CO4	2	-	-	-	2	2	2	2	1	1	-	2	1	2
CO5	1	-	-	-	2	2	2	2	1	1	-	2	1	2

20MUOE906 SDG NO. 4, 9 ,17	INTRODUCTION TO INDUSTRIAL AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know the concepts of hydraulics & pneumatics, components of hydraulic and pneumatic circuits and applications of hydraulics and pneumatics in automobiles.
- To realize the functions of fluid regulation and control elements and its typical uses in fluid power circuit and to acquire the practice on assembling the various types of pneumatic circuits.
- To familiar and exercise the design procedure of various types of pneumatic and hydraulic fluid power circuits and to provide a training to create the various types of hydraulic circuits.
- To learn about the fundamentals of Programmable Logic Controller.

UNIT I INTRODUCTION AND FLUID POWER GENERATION 9

Introduction to oil hydraulics and pneumatics, structure, advantages and limitations. ISO symbols, energy losses in hydraulic systems. Need For Automation, Classification of Drives - Hydraulic, Pneumatic and Electric –Comparison, applications, Basic types and constructions of Hydraulic pumps and motors. Pump and motor analysis.

UNIT II ACTUATORS AND CONTROL ELEMENTS 9

Actuators –functions, types, single acting cylinder - double acting cylinder- Rotary actuators - Unidirectional – Bidirectional actuators. Valves – functions – types, requirements - pressure control valve - pressure relief valve – pressure (counter) balance valve - pressure reducing valves, directional control valves - control of valves – manual – mechanical - hydraulic – pneumatic, combination valves - flow control valve, non-return/check valves, pilot operated sequence valve.

UNIT III PNEUMATIC SYSTEMS 9

Pneumatics – definition. Properties of air, humidity, Pneumatic Components - Air compressors-necessity- type's reciprocating-diaphragm-vane compressor, requirement of multi stage compressors, reservoirs- functions of reservoirs, air filter - screen type - bowl type, pressure regulators – diaphragm type, lubricator, FRL unit. Air motors- piston motor, gear motor, sliding vane motor.

UNIT IV HYDRAULIC AND PNEUMATIC CONTROL CIRCUITS 9

Intensifier circuits Meter-in, Meter-out and Bleed-off circuits; Fail Safe and Counter balancing circuits, Accumulator circuits - Regenerative circuits- pressure reducing circuits. Development of single and multiple actuator circuits. Speed control circuit for a double acting cylinder - time delay circuit.

UNIT V PROGRAMMABLE LOGIC CONTROLLER 9

Industrial Automation - Programmable Logic Controller - Functions of PLCs - Features of PLC - Selection of PLC - Architecture – Programming standard and types - Basics of PLC Programming – Ladder Logic Diagrams – Communication in PLC – Programming Timers and Counters.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Antony Esposito, "Fluid Power Systems and Control", Prentice-Hall, 2006.
2. Frank D, Petruzella, "Programmable Logic Controller" McGraw – Hill Publications, Fourth Edition, 2016.

REFERENCES:

1. John Watton, "Fundamentals of fluid power control", Cambridge University press, 2012.
2. Peter Rohner, "Fluid Power Logic Circuit Design", the Macmillan Press Ltd., London, 1979.
3. Majumdar S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw- Hill, 2001.

4. Majumdar, S.R., "Oil Hydraulics Systems – Principles and Maintenance", TataMcGraw Hill, 2001.
5. Srinivasan.R., "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 3rd edition, 2019.

WEB RESOURCES:

1. https://www.coursera.org/lecture/fluid-power/hydraulics-and-pneumatics-SD8dv
2. https://moodle.skillscommons.org/course/view.php?id=61
3. https://www.udemy.com/course/introduction-of-hydraulics-and-pneumatics/

ONLINE RESOURCES:

1. https://archive.nptel.ac.in/courses/112/106/112106300/
2. https://onlinecourses.nptel.ac.in/noc21_me51/preview
3. https://nptel.ac.in/courses/112106175
4. https://nptel.ac.in/courses/112105046

OUTCOMES:

Upon completion of the course, the students should be able to:

1. Recognize the various concepts of fluid power automation.(K1)
2. Explain functions, types, construction and working of different types of valves and actuators.(K2)
3. Explain purpose, types, construction and working of different components of pneumatic system.(K2)
4. Understand purpose, types and construction and working of different components of different hydraulic nd pneumatic circuits. (K2)
5. Demonstrate the standard fluid power circuits and PLC based interfaces.(K2)

CO – PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	-	2	-	-	-	-	-	1	2	1	2
CO2	1	1	1	-	1	-	-	-	-	-	1	2	1	-
CO3	1	1	1	-	2	-	-	-	-	-	2	2	1	2
CO4	1	1	1	-	1	-	-	-	-	-	1	2	1	-
CO5	1	1	1	-	2	-	-	-	-	-	1	2	1	-

20MUOE907 SDG NO. 4,8,9,12,13	APPLICATIONS OF 3D PRINTING TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand about concept of 3D printing
- To appreciate the role of 3D printing in food technology
- To appreciate the role of 3D printing in fashion technology
- To appreciate the role of 3D printing in construction technology
- To appreciate the role of 3D printing in healthcare Industry

UNIT I 3D PRINTING 9

History-Rapid Prototyping –ISO/ASTM 52915/21/- Additive Manufacturing-Process Steps in 3D printing-Classification of AM techniques- Advantages, Limitations.

UNIT II 3D PRINTING IN FOOD TECHNOLOGY 9

Printable food materials and properties, food product design- advantages & limitations, Food Safety laws and Regulation- Ethics- Software's, Advantages, Limitations, Future Aspects, case studies.

UNIT III 3D PRINTING IN FASHION TECHNOLOGY 9

Printable materials and properties, Fashion & Apparel design, N-topology, Conductive textiles, Smart Wearable electronics, printed garments, Sportswear, software's, Advantages, Limitations, Future Aspects, case studies.

UNIT IV 3D PRINTING IN CONSTRUCTION TECHNOLOGY 9

Printable materials and properties, Bio inspired designs, Advantages, Limitations, Future Aspects case studies.

UNIT V 3D PRINTING IN HEALTHCARE TECHNOLOGY 9

Printable materials and properties, Bio-printing, Modelling, pharmacology, forensic, Future Aspects

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Muralidhara HB, Soumitra Banarjee, "3D Printing technology and its diverse applications", CRC Press, AAP, 2022.
2. Ben Redwood, Filemon Schöffer, Brian Garret, "The 3D Printing Handbook: Technologies, design and applications", 1st ed., 3D Hubs, 2017.

REFERENCES:

1. Godoi, Fernanda C, Fundamentals of 3D food printing and applications, Elsevier Ltd. Academic Press, 2012.
2. Carlos BAÑÓN, Félix Raspall, "3D Printing Architecture: Workflows, Applications, and Trends" 1st ed., Springer Singapore, 2021.
3. Georgios Tsoulfas, Petros I. Bangeas, Jasjit S. Suri, "3D Printing: Applications in Medicine and Surgery", 1 ed., Elsevier, 2020.

WEB RESOURCES:

1. https://www.sculpteo.com/en/3d-printing/3d-printing-technologies/
2. https://all3dp.com/1/types-of-3d-printers-3d-printing-technology/
3. https://3dprinting.com/what-is-3d-printing/

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/107/103/107103081/
2. https://nptel.ac.in/courses/112/104/112104225/
3. https://www.coursera.org/learn/3d-printing-software
4. https://www.coursera.org/learn/3d-printing-applications
5. https://nptel.ac.in/courses/112/104/112104265/

OUTCOMES:

Upon completion of the course, the students should be able to:

1. Remember the role modern healthcare machines (K1)
2. Apply the concept of 3D printing in food technology (K2)
3. Apply the concept of 3D printing in fashion technology (K2)
4. Apply the concept of 3D printing in construction technology (K2)
5. Apply the concept of 3D printing in healthcare technology (K2)

CO – PO, PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	3	-	-	-	1	-	-	3	1	3
CO2	1	-	-	1	3	-	-	-	1	-	-	2	1	2
CO3	1	-	-	1	3	-	-	-	1	-	-	3	1	3
CO4	1	-	-	1	3	-	-	-	1	-	-	2	1	2
CO5	1	-	-	1	3	-	-	-	1	-	-	3	1	2

20MUOE908 SDG NO. 4, 9, 12	INTRODUCTION TO INDUSTRIAL ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The objective of this course is to provide foundation in Industrial Engineering in order to enable the students to make significant contributions for improvements in diverse organizations.
- Explain the concepts productivity and productivity measurement approaches.
- Explain the basic principles in facilities planning and plant location.
- Apply work study and ergonomic principles to design workplaces for the improvement of human performance
- Impart knowledge to design and implement Statistical Process control in any industry.
- Recognize the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages.

UNIT I INTRODUCTION **9**

Concepts of Industrial Engineering – History and development of Industrial Engineering –Roles of Industrial Engineer – Applications of Industrial Engineering – Production Management Vs Industrial Engineering – Production System – Input Output Model – Productivity – Factors affecting Productivity – Increasing Productivity of resources – Kinds of Productivity measures.

UNIT II PLANT LOCATION AND LAYOUT **9**

Factors affecting Plant location – Objectives of Plant Layout – Principles of Plant Layout – Types of Plant Layout – Methods of Plant and Facility Layout – Storage Space requirements – Plant Layout procedure – Line Balancing methods.

UNIT III WORK SYSTEM DESIGN & ERGONOMICS **9**

Need – Objectives – Method Study procedure – Principles of Motion Economy – Work Measurement procedures – Time Study –Work sampling- Ergonomics and its areas of application in the work system - Physical work load and energy expenditure, Anthropometry – measures – design procedure, Work postures-sitting, standing.

UNIT IV STATISTICAL QUALITY CONTROL 9

Definition and Concepts – Fundamentals – Control Charts for variables – Control Charts for attributes – Acceptance Sampling- O.C curve –Single sampling plan- Double sampling plan.

UNIT V STATISTICAL QUALITY CONTROL 9

Forecasting –Techniques – Types of production – Process planning – Economic Batch Quantity– Loading – Scheduling and control of production.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. O.P.Khanna, "Industrial Engineering and Management", Dhanpat Rai Publications, 2010.
2. Martand Telsang, "Industrial Engineering and Production Management", S. Chand and Company, 2006.

REFERENCES:

1. Ravi Shankar, Industrial Engineering and Management, Galgotia Publications & Private Limited, 2009.
2. Philip E. Hicks, Introduction to Industrial engineering and Management Science, Mc Graw Hill.
3. Stewart Black and Lyman W. Porter, Management – Meeting New Challenges, Prentice Hall
4. Stephen P. Robbins and David A. Decenzo, Fundamentals of Management, Pearson Education.
5. Gavriel Salvendy, Hand Book of Industrial Engineering & Management, John Willey & Sons.

WEB RESOURCES:

1. https://www.newtondesk.com/industrial-engineering-study-notes-hand-written/
2. https://ftp.idu.ac.id/wp-content/uploads/ebook/ip/BUKU%20INDUSTRIAL% 20ENGINEERING/Industrial%20Engineering%20And%20Management%20by%20Kumar,%20Pravin%20(z-lib.org).pdf

ONLINE RESOURCES:

1. https://archive.nptel.ac.in/courses/112/107/112107143/
2. https://archive.nptel.ac.in/courses/112/107/112107292/#
3. https://onlinecourses.nptel.ac.in/noc22_me04/preview

OUTCOMES:

Upon completion of the course, the students should be able to:

1. Understand the concepts of productivity and productivity measurement approaches. (K1)
2. Evaluate appropriate location models for various facility types and design various facility layouts (K2)
3. Conduct a method study and time study to improve the efficiency of the system.
4. Control the quality of processes using control charts in manufacturing/service industries. (K3)
5. Obtain sufficient knowledge and skill for Planning strategies and Material Requirement Plan. (K2)

CO-PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	2	2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	2	2	2	1	1	-	-	2	-	-	1	-	-	-
CO4	2	2	3	1	1	-	-	-	-	-	-	-	-	-
CO5	1	2	2	-	-	-	-	-	-	-	-	1	-	-

20MUOE909 SDG NO. 3,4,9,12	INTRODUCTION TO CNC SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand evolution and principle of CNC machine tools
- Describe constructional features of CNC machine tools
- Generate CNC programs for popular CNC controllers
- Describe machine tools and work holding devices for CNC machine tools.

UNIT I INTRODUCTION **9**

Introduction to Automation – Goals of Automation, levels of automation, Hard Vs Soft Automation, Computer Aided manufacturing (CAM). Evolution of CNC Technology - Numerical Control - Introduction, Role of NC / CNC in CAM, Applications of NC / CNC, Benefits of NC / CNC, Limitations of CNC.

UNIT II COMPONENTS OF CNC SYSTEM 9

Basic Components of CNC system - Part programming, Machine control unit, Machine tool - Historical developments and their role in control of machine tools. Classification of NC / CNC systems - Based on type of Control, method of programming, type of architecture - Hardwired / Softwired / Open.

UNIT III INTERPOLATORS AND CONTROLLERS 9

Machine Control Unit - Data processing Unit - elements and their functions - Interpolators and Sequential Controllers. Interpolators - Types and Stages of Interpolation, Principles of interpolation. Methods of programming.

UNIT IV PART PROGRAMMING 9

Part programming – Introduction - Part Program and its elements, Methods of Programming - Manual and Computer Assisted Part programming - Tool path generation and control methods.

UNIT V MACHINE TOOLS 9

Machine Tool - Drives and controls, Automatic Tool Changers. Introduction to free form surface machining. Automatic Pallet Changers, tool offsets and work offsets, high speed and precision machining concepts-work holding devices.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Koren Y, —Computer Control of Manufacturing systems||, McGraw Hill, 2017.
2. Alan Overby —CNC Machining Handbook: Building, Programming, and Implementation|| McGraw-Hill Education, 2010.

REFERENCES:

1. Reinbold U, Blume C and Dilmann R, —Computer Integrated Manufacturing Technology & Systems||, Marcel Dekker, 1985.
2. John W, —Programmable Controllers - Principles and Applications|| Merrill Publ.Co, New York, 1980.
3. Madison J, —CNC machining Handbook||, Industrial Press Inc., 1996.
4. Barry Leatham - Jones, Introductions to Computer Numerical Control, Pitman, London - John willey & Sons, 1986.
5. 5. Roger S. Pressman & John E. Williams, Numerical Control and Computer Aided Manufacturing, John Willey, 1977.

WEB RESOURCES:

1. https://www.coursera.org/courses?query=cnc
2. https://opensource.com/article/19/1/cnc-milling-open-source-software
3. https://www.udemy.com/topic/cnc/

ONLINE RESOURCES:

1. https://archive.nptel.ac.in/courses/112/105/112105211/
2. https://nptel.ac.in/courses/112102103

OUTCOMES:

Upon completion of the course, the students should be able to:

1. Explain the fundamentals of CNC machines, differentiate the advantages and disadvantages of different types of CNC machines (K1)
2. Recognize the basic structure, construction, working and control of CNC machines (K2)
3. Develop a CNC Part programming for the basic operations (K2)
4. Classify different types of interpolators and controllers (K2)
5. Be familiar with different machine tools and work holding devices of CNC (K2)

CO- PO, PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-	1	2	-	-	-	-	1	1	2	1
CO2	2	1	-	-	1	-	-	-	-	-	1	1	2	1
CO3	2	1	2	-	1	2	-	-	2	-	1	2	2	2
CO4	2	1	-	-	1	-	-	-	-	-	1	1	2	1
CO5	2	1	2	-	1	2	-	-	2	-	1	2	2	2

20MUOE910 SDG NO. 3,4,5,11,12	PRINCIPLES OF SUSTAINABLE DESIGN AND PRODUCTION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To make the students to understand the importance of Design for Environment with respect to existing and future world.
- To understand the guidelines and rules for various forms of design.
- To implement reliability and product life cycle estimation tools in green manufacturing.
- To create awareness in current sustainable practices in manufacturing industry.

UNIT I INTRODUCTION TO SUSTAINABLE MOVEMENT 9

Environmental concerns of the modern society- Overview of production industry and their relevant regulations in China, European Union and other key countries- global and regional strategy and policy on process and manufacturing industry. The global sustainability Agenda – The response of industry. External drivers: The voice of society – Green Expectation – Confronting climate change – Government initiatives: Stick and Carrot – Environmental Management System Standards – Sustainable Rating Schemes – Voluntary codes and principles

UNIT II PRINCIPLES OF SUSTAINABLE DESIGN 9

Principles of design for environment – Lice cycle thinking – System perspective – Indicators and Metrics – Design strategies – Analysis method – Information technology – Learning from Nature – From principle to practices. Design for Dematerialization – Design for Energy and material conservation – Design for source reduction.

UNIT III DESIGN RULES AND ANALYSIS METHODS 9

Design for servicization – Design for Detoxification - Design for release reduction – Design for hazard reduction – Design for Benign waste disposition. Tangible Evaluation – Quantitative Assessment – Environmental analysis – Foot print indicators, life cycle assessment, predictive simulation – Risk Analysis – Financial analysis – Examples for DFE decisions - The challenges of Decision making.

UNIT IV SUSTAINABLE DESIGN DECISION AND PRODUCTION 9

Stages of product development process in green design: Materials-Manufacturing - Packaging and use - End of Life and disposal - Design for recycling - Life Cycle Assessment (LCA), and Eco-design tools - Environmental

management systems, and International standards - Eco-design in mechanical/electronics industry - Sustainable Mobility research – DFE in the transportation life cycle – General motors': Products and process Innovation - Realizing Sustainable growth - Consumer products industries.

UNIT V CASE STUDIES ON WASTE RECYCLING 9

Recycling technologies for paper, glass, metal, plastic – Used Lead Acid Battery Recycling – End of Life Vehicle Recycling – Electronic Waste Recycling – Waste Oil Recycling – Solvent Recovery Drivers and barriers for material recycling: social, legal and economic factors - Environmental impacts of waste recycling.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Joseph Fiksel, Design for Environment – A guide to sustainable Product Development, second edition, McGraw Hill, 2012.
2. Ibrahim Garbie, "Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0", Springer International Publishing., United States, 2016.

REFERENCES:

1. Dorothy Mackenzie, L. King, Green Design: Design for the Environment, 1997.
2. Nand K. Jha, Green design and manufacturing for sustainability CRC Press, 2016.
3. Kurt marcel, callisto, sustainable energy systems and technology, 2016.
4. Gary C. Young, Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, John Wiley & Sons, 2010.
5. Seliger G., "Sustainable Manufacturing: Shaping Global Value Creation", Springer, United States, 2012.

WEB RESOURCES:

1. https://guides.library.illinois.edu/c.php?g=347670&p=2344606
2. https://www.gsa.gov/real-estate/design-and-construction/sustainability/sustainable-design
3. https://www.designorate.com/principles-of-sustainable-design/

ONLINE RESOURCES:

1. https://www.classcentral.com/course/independent-principles-of-sustainable-design-8000
2. https://nptel.ac.in/courses/107103081
3. https://nptel.ac.in/courses/124106157

OUTCOMES:

Upon completion of the course, the students should be able to:

1. Understand the art and science of design environment. (K1)
2. Impart the knowledge to analyze methods for design decisions. (K2)
3. Explain the design rules and guidelines in preserving the environment. (K2)
4. Describe various sustainable decisions for design environment(K2)
5. Discuss various case studies for different applications. (K2)

CO- PO, PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	1	-	2	-	-	-	1	2	-	2
CO2	-	-	-	-	1	-	2	-	-	-	2	2	-	2
CO3	1	1	1	-	1	-	2	-	-	-	2	2	1	2
CO4	-	-	-	-	1	-	2	-	-	-	1	2	-	2
CO5	-	-	-	-	1	-	2	-	-	-	2	2	-	2