SCHEME OF EXAMINATION

&

SYLLABI

for

Master of Technology in: Robotics and Artificial Intelligence

Offered by

University School of Information, Communication and Technology at its Dwarka Campus

w.e.f. Academic Session 2026-27

GURU GOBIND SINGH
INDRAPRASTHA
UNIVERSITY

Guru Gobind Singh Indraprastha University
Sector 16C, Dwarka, Delhi – 110 078 [INDIA]
www.ipu.ac.in

With effect from academic session 2026-27.

Approval History:

1. **1st and 2nd year Scheme and syllabus (for 1st semester) for M.Tech. (Robotics and Artificial Intelligence) programmes, and Regulations implemented from 2026-27 batch, approved by Board of Studies meeting of University School of Information and Communication Technology held on 08.08.2026.**
2. **1st and 2nd year Scheme and syllabus (for 1st semester) for M.Tech. (Robotics and Artificial Intelligence) programmes, and Regulations implemented from 2026-27 batch, approved by Academic Council sub-Committee on 19.08.2026.**

Vision of the School

Create high-quality engineering professionals

Mission of the School

To serve humanity by creating professionally competent, socially sensitive engineers with high ethical values who can work as individuals or in groups in multicultural global environments.

With effect from academic session 2026-27.

Introduction

This document describes the curriculum of the Master of Technology Programmes that are offered at the University School of Information, Communication and Technology. In the event of any difficulty of implementation, and / or interpretation of any clause of the document, the same may be brought to the notice of Dean of the University School of Information Communication and Technology. The decision of the Dean, University School of Information Communication and Technology shall be final and implemented to resolve the issue. The same shall be put up in the subsequent meeting of the Board of Studies of the University School of Information Communication and Technology for its approval. If the decision of the Board of Studies of the University School of Information Communication and Technology is at variance with the decision taken earlier by the Dean of the School, the decision of the Board shall be effective from the date of the approval by the Board of Studies. In the interim period (between the approval of the Dean, of the School and the Board of Studies approval), the decision already taken by the Dean of the school shall stand.

In view of the admission scenario, these programme of studies shall be offered only at the schools of the University or government institutions affiliated to the University. It shall not be offered to self-financing institutions unless specifically approved by the Academic Council of the University.

The scheme and syllabus defined in this document shall be also applicable to the corresponding Master of Technology programmes of the dual degree scheme.

This document defines the scheme and syllabus of the programmes of study for the following degree nomenclature:

Master of Technology in Robotics and Artificial Intelligence (M.Tech. R&AI)

Scheme and Syllabus

With effect from academic session 2026-27.

Course / Paper Group Codes:
HS: Humanities, social science, management
PC: Programme Core, that is course / paper offered in the discipline of the programme as a compulsory paper.
EA: Emerging Area Elective offered by school. This allows a student to opt for Minor Specialization
OA: Open area elective offered by other school or other schools or Swayam /MOOCS

Acronyms:

APC: Academic programme committee comprising of all faculty of the school.
L: Number of Lecture hours per week
P: Number of Practical Hours per week
C: Number of credits assigned to a course / paper
NUES: An evaluation scheme in which evaluation is conducted by a committee, a teacher or a group of teacher as described in the scheme of study.
COE: Controller of Examinations of the Examinations Division of the University.

Master of Technology in Robotics and Artificial Intelligence
(2 Year Regular Programme)

With effect from academic session 2026-27.

Programme Educational Objectives for M.Tech. (Robotics and Artificial Intelligence) Programme

PEO1: To develop students to critically analyze the problems in the field of Robotics and Artificial Intelligence and find optimal solutions.
PEO2: To train students to conduct research and experiments by applying appropriate techniques and tools with an understanding of the limitations for sustainable development of society.
PEO3: To prepare students to act as a member and leader of the team to contribute positively to manage projects efficiently in the field of Robotics and Artificial Intelligence.
PEO4: To train the students to effectively communicate, write reports, create documentation and make presentations by adhering to appropriate standards.
PEO5: To stimulate students for life-long learning with enthusiasm and commitment to improve knowledge and competence continuously.

Program Specific Outcomes for M.Tech (Robotics and Artificial Intelligence) Programme

PO1: An ability to independently carry out research /investigation and development work to solve practical problems
PO2: An ability to write and present a substantial technical report/document
PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PO4: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

CO-PEO Matrix*

Filled on a scale of 1 to 3 (3=High; 2=Moderate; 1=Low; '-'for no correlation)

Program Specific Outcomes	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	3	3	2	2	2
PO2	3	1	2	3	1
PO3	3	3	3	2	3
PO4	1	2	3	2	2

M.Tech. (Robotics & Artificial Intelligence)

First Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**Credits**
Theory Papers					
PC	RAI501	Computational Mathematics	3		3
PC	RAI503	Robotics Engineering	4		4
PC	ICT505	Soft Computing	4		4
PC	RAI507	Mechatronics System Design	3		3
PC	RAI509	Signal and Image Processing	3		3
HS	ICT511	Scientific Writing**	2		2
Practical/Viva Voce					
PC	RAI551	Computational Mathematics Lab	-	2	1
PC	RAI553	Robotics Engineering Lab	-	2	1
PC	RAI555	Mechatronics System Design Lab	-	2	1
PC	ICT567	Soft Computing Lab	-	2	1
PC	RAI559	Signal and Image Processing Lab	-	2	1
PC	ICT559	Term Paper – 1*			1
Total					**25**

*NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

**NUES: The evaluation shall be conducted by the concerned teacher as continuous assessment. The marks shall be awarded out of 100 (maximum marks).

Second Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**Credits**
Theory Papers					
PC	RAI502	Mobile Robots	4		4
PC	RAI504	Artificial Intelligence in Robotics	4		4
PC	ICT506	Computational Optimization	4		4
EA	RAI512	Computer Vision	4		4
EA	RAI510	Control Theory	4		4
PC	ICT508	Research Methodology	2		2
Practical/Viva Voce					
PC	RA552	Artificial Intelligence Lab	-	2	1
PC	ICT586	Optimization Lab	-	2	1
PC	RAI556	Computer Vision lab	-	2	1
PC	RAI558	Control Lab	-	2	1
PC	ICT588	Term Paper – 2*			1
Total					**27**

*NUES: The evaluation shall be conducted by a duly constituted committee of teachers by the APC of the school / department /institution. The marks shall be awarded out of 100 (maximum marks).

Third Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**Credits**
Theory Papers					
PC	RAI601	Modelling and Simulation	3		3
PC	RAI603	Drone Technology	3		3
PE		**Elective I (Choose any one)**			
One Course[@]	RAI605	Computer Integrated Manufacturing	4		4
	RAI607	Rehabilitation and Medical Robots	4		4
	RAI609	Micro and Nano Electro Mechanical Systems	4		4
	RAI611	Adaptive and Robust Control	4		4
PE		**Elective-II (Choose any ONE)**			
One Course[@]	ICT631T	Machine Learning	3		3
	ICT631P	Machine Learning Lab		1	1
	RAI613	Design of Robotic Manipulators	4		4
One Course[@]	ICT513	Wireless Sensor Networks	4		4
	ICT671T	VLSI Technology	3		3
	ICT671P	VLSI Technology Lab		1	1
OE		**Open Elective (Choose any ONE)**			
	RAI619	Embedded and Internet of Things	4		4
	ICT635T	Deep and Reinforcement Learning	3		3
	ICT635P	Deep and Reinforcement Learning Lab		1	1
	ICT655T	Programming with Arduino and Raspberry -Pi	3		3
	ICT655P	Programming with Arduino and Raspberry -Pi Lab		2	1
	ICT627T	ESD using ARM Microcontroller			
		Courses offered by other University Schools for the M.Tech. Students			
		Courses offered through SWAYAM / NPTEL MOOCs platform			
PC	ICT603	Human Values and Ethics*	2		2
Practical/Viva Voce					
PC	RA651	Modelling and Simulation Lab	-	2	1
	RA653	Drone Technology Lab	-	2	1
PC	ICT653	Major Research Project Part – I**	-	-	4
Total					**26**

** The research project guideline shall be issued separately by the school with the approval of the Dean, USICT

* NUES: The evaluation shall be conducted by the concerned teacher as continuous assessment. The marks shall be awarded out of 100 (maximum marks).

[@] The theory and the practical components form one paper

Fourth Semester					
Group	**Code**	**Paper**	**L**	**T/P**	**Credits**
Practical/Viva Voce					
PC	ICT652	Major Research Project Part – II**	-	-	22
Total					**22**

** The research project guideline shall be issued separately by the school with the approval of the Dean, USICT

Total: 100 Credits

1. The total number of credits of the Programme M. Tech. = 100.
2. Each student shall be required to appear for examination in all courses, but for the award of the degree a student shall be required to earn the minimum of 90 credits out of 100. However, only Elective Courses and Term papers may be dropped towards counting for total credits of 90 to award M. Tech. Degree.

Rules:

By default, every student shall do the Major Research Project Part II. However, a student can do internship also but that would not, in any case, replace Major Research Project Part II. The student must apply to the school for approval to do internship before the commencement of the 4th semester to the school, and only after approval of Dean of the school / Director of Institution / In-charge of the programme of study, through Training and Placement Officer of the School, shall proceed for internship. However, evaluation shall be done only for the Major Research Project Part – II only.

The student shall be allocated a supervisor / guide for Term Papers / Major Research Project work at the beginning of respective semesters by the school. The Major Research Project Part - I shall continue into the 4th semester as Major Research Project Part – II.

For project work, the students shall be awarded marks out of 40 on the basis of supervisors' continuous evaluation and mid semester progress report evaluation by a committee constituted by Dean. The students shall be awarded marks out of 60 on the basis of an external evaluation conducted by an external examiner deputed by examinations division (CoE).

* Comprehensive evaluation by a committee of teachers, constituted by the Academic Programme Committee, out of 100.

Note: *In the absence of the supervisor or the Training and placement officer (as the case may be), the Dean of the school can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the school.*

Implementation Guidelines:

1. This regulation shall apply to the Master of Technology part of the Master of Technology programme in Robotics and Artificial Intelligence (primary discipline), offered at University School of Information, Communication and Technology.
2. This programme of studies shall be offered only at the schools of the University or government institutions affiliated to the University,
3. Total Number of Credits: 100
4. Maximum marks for every paper shall be 100.
5. The student shall be allocated a supervisor / guide for Term Papers / Major Research Project work at the beginning of respective semesters by the school. The Major Research Project Part - I shall continue into the 4th semester as Major Research Project Part – II.
6. By default, every student shall do the Major Research Project Part II. However, a student can do internship also but that would not, in any case, replace Major Research Project Part II. The student must apply to the school for approval to do internship before the commencement of the 4th semester to the school, and only after approval of Dean of the school / Director of Institution / In-charge of the programme of study, through Training and Placement Officer of the School, shall proceed for internship. However, evaluation shall be done only for the Major Research Project Part – II only.
7. For project work, the students shall be awarded marks out of 40 on the basis of supervisors' continuous evaluation and mid semester progress report evaluation by a committee constituted by Dean. The students shall be awarded marks out of 60 on the basis of an external evaluation conducted by an external examiner deputed by examinations division (CoE).
8. For NUES Papers Comprehensive evaluation by a committee of teachers or the concerned teacher, constituted or deputed by the Academic Programme Committee, out of 100.
9. The examinations, attendance criteria to appear in examinations, promotion and award of the degree shall be governed by the Ordinance 11 of the University.
10. Minimum duration of the Master of Technology programme shall be 2 years (N=2 years) (4 semesters).
11. Maximum duration of the Master of Technology programme shall be 4 years (N+2 years).
12. The open electives of the OA group of courses may be taken through SWAYAM / NPTEL MOOCs platform. The student desirous of doing a MOOC based course among the OA group must seek approval of the APC of the school for the same before the commencement of the semester. The APC shall allow the MOOC based OA option to the student if and only if the MOOC subject / course being considered for the student is being offered in line with the Academic Calendar applicable. The student shall submit the successful completion certificate with marks to the School for onwards transfer to the Examination Division. The Examinations Divisions shall take these marks on record for incorporation in the result of the appropriate semester. These courses shall be used for calculation of the SGPA/CGPA of the student concerned by the examination division of the University.
13. These MOOC courses taken by the students, if allowed by the APC of the school shall be of 4 credits or more collectively. If the credit of these MOOC Courses, allowed to a student is more than 4, then the maximum credit for the programme shall be amended accordingly for the particular student. Also, in a particular semester, a student may take more than one MOOC course with the approval of the APC to meet the credit requirements of OA for the semester.
14. OA Group courses / papers to be offered to a particular batch, shall be notified by the School, subject to availability of minimum number of students willing to opt for a paper / group and the availability of faculty offering that paper / group.
15. OA group paper is droppable in the sense that the student may qualify for the award of the degree even when the student has not cleared / passed the paper of this group. However, the student must earn the minimum credits **(100)**for the programme of study as specified.
16. The student must appear for all 100 credits to be considered for the award of the degree.
17. The degree of "**Master in Technology in Robotics and Artificial Intelligence**" shall be conferred to the student if and only if the student satisfies the following:
    a. The students has appeared in all the papers offered (at least 100 credits)

b. The student has acquired at least 90 credits from all the papers (other than the open elective).

18. Pass marks in every paper shall be 40.
19. Grading System shall be as per Ordinance 11 of the University.

Detailed Syllabus

With effect from academic session 2026-27.

Paper Code: RAI 501	Paper: Computational Mathematics
Paper ID:	
Prerequisite Paper: Engineering Mathematics	
Instructions for the paper setter:	

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. It will have five parts of 5 marks each.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 10.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Outcomes (CO):

CO1:	Ability to write simple MATLAB programs related to numerical methods.
CO2:	Ability to implement different root finding algorithms
CO3:	Ability to implement trapezoidal and simpson's rules.
CO4:	Ability to solve ordinary differential equations and Fourier transform methods.

CO vs PO:

	PO1	PO2	PO3	PO4
CO1	3	-	3	-
CO2	3	-	3	-
CO3	3	-	3	-
CO4	3	-	3	-

Unit I

MATLAB Fundamentals: The MATLAB Environment, Assignment, Mathematical Operations, Use of Built-In Functions, Graphics,M-Files, Input-Output, Structured Programming, Nesting and Indentation, Passing Functions to M-Files, Types of Computer Errors, IEEE 64-bit Floating-Point Number Representation, Vectors in MATLAB Finding Roots by Bracketing Methods and Open methods, Optimization: Unconstrained Optimization, Constrained Optimization, MATLAB Built-In Routines for Optimization

Unit II

Matrix Algebra Overview, Solving Linear Algebraic Equations with MATLAB, Gauss Elimination, LU Factorization, Cholesky Factorization, Matrix Inverse and Condition, Iterative Methods, Eigenvalues, Interpolation and Curve Fitting: Interpolation by Lagrange, Newton, and Chebyshev Polynomial, Hermite Interpolating Polynomial, Cubic Spline interpolation, Straight Line, Polynomial Curve, and Exponential Curve Fit.

Unit III

Numerical Integration Formulas: Newton-Cotes Formulas, Trapezoidal Rule, Simpson's Rules, Romberg Integration, Gauss Quadrature, Adaptive Quadrature Numerical Differentiation: Richardson Extrapolation, Derivatives of Unequally Spaced Data, Derivatives and Integrals for Data with Errors, Numerical Differentiation with MATLAB.

Unit IV

Ordinary Differential Equations: Euler's Method, Runge-Kutta Methods, Multistep Methods, Boundary-Value Problems Fourier Analysis: Curve Fitting with Sinusoidal Functions, Continuous Fourier Series, Frequency and Time Domains, Fourier Integral and Transform, Discrete Fourier Transform (DFT)

Textbooks:

1. Applied Numerical Methods with MATLAB for Engineers and Scientists by Steven C. Chapra, McGraw Hill Education, 3rd ed,2017.
2. Introduction to Matlab for Engineers by William J. Palm III, McGraw Hill Education,2011

References:

1. Applied Numerical methods using MATLAB by W. Y. Yang, Wiley Publications, 2005

Paper Code: RAI 503/ ICT613	Paper: Robotics Engineering
Paper ID:	
Prerequisite Paper: Engineering Mathematics, Engineering Mechanics	
Instruction for paper setter:	

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. It will have five parts of 5 marks each.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain up to 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 10.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Outcomes (CO):

CO1:	Ability to understand the various parts and their functioning used in robot. Ability to develop the knowledge of various drive systems used in robots.
CO2:	Ability to solve the problems of kinematic of robots.
CO3:	Ability to solve the problems of dynamics of robots.
CO4:	Ability to understand the various sensors used in robots. Ability to acquire the basic knowledge of the programming languages used in robots. Also, ability to understand the role of robots in industries through case studies.

CO vs PO:

	PO1	PO2	PO3	PO4
CO1	3	1	3	1
CO2	3	-	3	1
CO3	3	-	3	1
CO4	3	2	3	1

Unit I: Introduction

A brief history of robots, Automation and Robotics, Classification of robots, Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. End effectors, Grippers-Mechanical grippers, Magnetic grippers, Vacuum grippers, Air operated grippers; Specifications of robot, Economic analysis for robots.

Drive Systems- hydraulic, pneumatic and electric systems.

Unit II: Kinematics of Robots

Descriptions of positions, orientation and frames, mapping of frames, transformations and operators, Euler angles and Euler transformations, D-H representation, Inverse kinematics, Time varying position and orientation, Linear and rotational velocity, Velocity propagation from link to link, Jacobians.

Unit III: Dynamics of Robots

Newton's equation, Euler's equation, Newton-Euler dynamic formulation, Lagrangian formulation of manipulator dynamics, Dynamic equations for multiple DOF robots, Static force analysis of robots.

Trajectory generation: Basics of trajectory planning, Cartesian space trajectories.

Unit IV: Sensors, Robot Control, Programming and applications

Sensors in robot: Introduction of various sensors used in manipulator.

Robot controls: Point to point control, Continuous path control, Control system for robot joint, Feedback devices, Motion Interpolations, Adaptive control.

Introduction to Robotic Programming, On-line and off-line programming, programming examples.

Robot applications-Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting, Health sector, Space and underwater robots.

Textbooks:

1. *Mikell P. Groover, Mitchel Weiss, Roger N Nagel, Nicholas G. Odrey, Ashish Dutta, "Industrial Robotics: Technology programming and Applications", McGraw Hill, 2012.*
2. *John J. Craig. "Introduction to Robotics- Mechanics and Control", Third Edition,Addison- Wesley, 2004.*

References:

1. *S.R. Deb, "Robotics Technology and flexible automation", Tata McGraw-Hill Education., 2009.*
2. *Richard D. Klafter, Thomas .A, ChriElewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning., 2009.*
3. *C. Ray Asfahl, "Robots and Manufacturing Automation", John Wiley & Sons Inc.,1985*
4. *Carl D. Crane and Joseph Duffy, "Kinematic Analysis of Robot manipulators", Cambridge University press, 2008.*

Paper Code: ICT505	Paper: Soft Computing
Paper ID:	
Prerequisite Paper:	
Instructions for the paper setter:	

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. It will have five parts of 5 marks each.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 10.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Outcomes (CO):

CO 1	Understand soft computing techniques like Neural Networks and their role in problem solving.
CO 2	Conceptualize and parameterize various problems to be solved through basic soft computing techniques in Fuzzy systems
CO 3	Analyze and integrate various Evolutionary algorithms in order to solve problems effectively and efficiently.
CO 4	Understand use of Rough sets and Hybrid Systems in problem solving

CO vs PO:

	PO1	PO2	PO3	PO4
CO 1	3	1	3	2
CO 2	3	1	3	2
CO3	3	2	3	2
CO4	3	2	3	1

UNIT – I

Introduction: Introduction to Soft Computing Concepts, Importance of tolerance in imprecision and uncertainty, Soft Computing Constituents and Conventional Artificial Intelligence, From Conventional AI to Computational Intelligence, Fuzzy Set Theory, Neural Networks and Evolutionary Computation

Neural Networks: Overview of biological Neuro-system, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms-Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms-perceptions, Training rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model, Hopfield Networks, Associative Memories, Applications of Artificial Neural Networks.

UNIT – II

Introduction to Fuzzy Sets: Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations.

Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations.

Fuzzy Logic: Classical Logic, Multivalued Logics, Fuzzy Propositions, Fuzzy Qualifiers, Linguistic Hedges.

Uncertainty based Information: Information & Uncertainty, Nonspecificity of Fuzzy & Crisp Sets, Fuzziness of Fuzzy Sets, Defuzzyfication.

UNIT – III

Evolutionary Computation: Genetic Algorithms and Genetic Programming, Evolutionary Programming, Evolutionary Strategies and Differential Evolution Coevolution, Different operators of Genetic Algorithms, Analysis of Selection Operations, Convergence of Genetic Algorithms

UNIT - IV

Rough Sets: Introduction, Imprecise categories Approximations and Rough Sets, Reduction of Knowledge, Decision Tables, and Applications.
Hybrid Systems: Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks.Fuzzy Logic bases Neural Networks, Genetic Algorithm for Neural Network Design and Learning, Fuzzy Logic and Genetic Algorithm for Optimization, Applications.

Textbook(s) / Reference(s):

1. Anderson J.A, “An Introduction to Neural Networks”, PHI, 1999.
2. Hertz J. Krogh, R.G. Palmer, “Introduction to the Theory of Neural Computation”, Addison-Wesley, California, 1991.
3.Neural Networks-A Comprehensive Foundations”, Prentice-Hall International, New Jersey,1999.
4.Freeman J.A. & D.M. Skapura. “Neural Networks: Algorithms, Applications and Programming Techniques”, Addison Wesley, Reading, Mass, 1992.
5.G.J. Klir& B. Yuan, “Fuzzy Sets & Fuzzy Logic”, PHI, 1995.
6.Melanie Mitchell, “An Introduction to Genetic Algorithm”, PHI, 1998.

PaperCode: RAI 507	Paper: Mechatronics System Design
Paper ID:	
Prerequisite: Linear Algebra, Engineering Mathematics, Basic Electronics, and C/Python Programming	
Instruction for paper setter:	
1. There should be 9 questions in the term end examinations question paper. 2. The first question should be compulsory and cover the entire syllabus. It will have five parts of 5 marks each. 3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 10. 4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook. 5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required	

Course Outcomes (CO):

CO 1	Ability to develop understanding of the basic functioning of mechatronics system and use of sensors, transducers and their importance with respect to precision and accuracy in applications of mechatronics systems.
CO 2	Ability to develop understanding of the basic functioning of Mechanical, Hydraulic, Pneumatic, Electrical actuation systems and PLC in mechatronics system design.
CO 3	Analyze and design feedback control system and use AI/ML tools to understand the behaviour.
CO 4	Ability to develop understanding of Deployment of AI/ML to existing systems.

CO vs PO:

	PO1	PO2	PO3	PO4
CO 1	3	2	3	2
CO 2	3	3	3	3
CO3	3	2	3	2
CO4	3	3	3	3

UNIT-I

Introduction: Introduction to Mechatronics System, mechatronics in manufacturing, product and design, Measurement Systems, Control System, comparison between traditional and mechatronics approach.
Sensors and Transducers: Introduction, Performance terminology, Displacement, Position and Proximity, Velocity and motion, Fluid pressure, Temperature sensors, Light sensors, Selection of sensors.

UNIT-II

Mechanical Actuation System: Cams, Gear trains, Ratchet and Pawl, Belt and chain drives, Bearings.
Hydraulic and Pneumatic Actuation System: Introduction to Hydraulic and Pneumatic Systems, Directional Control valves, Flow control valves.
Electrical Actuation System: Electrical systems, Solid State Switches, Solenoids, D.C. motors, A.C. motors, Stepper motors.

UNIT-III

Microprocessors: Microprocessor systems, Microcontrollers, applications.
Programmable Logic Controllers: Basic PLC structure, Input/output processing, ladder programming, latching and internal relays, Sequencing, Timers and counters, Shift registers, Master and jump controls, Code conversion, Data handling, selection of PLC.

UNIT-IV

AI inclusion in Mechatronics: Signal Conditioning and Data Acquisition, Mechatronic Actuation, Embedded Firmware Architecture, RTOS for Safety-Critical Systems, Building physics-accurate CAD models in simulation environments.
Design of Mechatronics systems: Designing mechatronics system, Case studies of Mechatronics system like Pick and place robots, automated guided vehicle, Automatic car park barrier, Engine management system.

Text Books:

1. W.Bolton, “Mechatronics” , Pearson education, second edition, fifth Indian Reprint, 2003.
2. A. Smaili and F. Mrad, "Mechatronics- integrated technologies for intelligent machines", Oxford university press, 2008.
3. Raj Kamal, “Embedded Systems Architecture Programming and Design”, Tata McGraw-Hill publishing Company Ltd, 2007.

Reference Books:

1. R.K Rajput, A textbook of mechatronics, S. Chand & Co, 2007.
2. Michael B. Histand and David G. Alciatore, “ Introduction to Mechatronics and Measurement Systems”, McGraw-Hill International Editions, 2000.
3. D. A. Bradley, Dawson D., Buru N.C. and. Loader A.J, “Mechatronics”, Chapman and Hall, 1993.
4. Dan Necsulesu, “Mechatronics”, Pearson Education Asia, 2002 (Indian Reprint).
5. Lawrence J. Kamm, “Understanding Electro – Mechanical Engineering”, An Introduction to Mechatronics, Prentice – Hall of India Pvt., Ltd., 2000.
6. Nitaigour Premchand Mahadik, “Mechatronics”, Tata McGraw-Hill publishing Company Ltd, 2003.

Paper Code: RAI509	Paper: Signal and Image Processing
Paper ID:	
Prerequisite Paper:	
Instructions for the paper setter:	

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. It will have five parts of 5 marks each.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 10.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Outcomes (CO):

CO 1	Ability to understand the mathematical foundations of digital signal and image processing
CO 2	Ability to understand the digital signal processing algorithms using transform and filtering techniques.
CO 3	Ability to implement the image enhancement techniques in spatial and frequency domains.
CO 4	Ability to understand to use the image restoration, wavelet-based and segmentation algorithms for practical applications.

CO vs PO:

	PO1	PO2	PO3	PO4
CO 1	3	3	3	3
CO 2	3	3	3	3
CO3	3	3	3	3
CO4	3	3	3	3

Unit I

Mathematical Foundations and Signal Representation:

Introduction to continuous-time and discrete-time signals, classification of signals, signal operations, Linear Time-Invariant (LTI) systems, convolution and correlation, linear constant coefficient difference equations, sampling theorem, aliasing, Z-transform and its properties, Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT), power spectral density.

Unit II

Digital Signal Processing

Structures for the Realization of Discrete-Time Systems, Structures for FIR Systems, Structures for IIR Systems; Design of FIR Filters: Design of Linear-Phase FIR Filters Using Windows, Design of Linear-Phase FIR Filters by the Frequency-Sampling Method, IIR Filter Design by Approximation of Derivatives, IIR Filter Design by Impulse Invariance, IIR Filter Design by the Bilinear Transformation; Introduction to adaptive filtering.

Unit III

Fundamentals of Digital Image Processing

Image acquisition, image sampling and quantization, image representation, pixel relationships, connectivity and distance measures, human visual system, gray-level transformations, histogram processing, histogram equalization, arithmetic and logical

operations, spatial filtering, smoothing and sharpening filters, two-dimensional Fourier transform, frequency-domain image enhancement.

Unit IV

Image Restoration and Advanced Image Processing

Image degradation/restoration model, noise models, image denoising, inverse filtering, image compression, edge detection, thresholding, region-based segmentation, watershed segmentation, feature extraction using HOG, PCA etc.; applications in medical imaging, intelligent vision systems.

Textbooks:

1. Gonzalez, R. C., and Woods, R. E., Digital Image Processing, 4th Edition, Pearson Education, New Delhi, 2018.

2. Oppenheim, A. V., and Schafer, R. W., Discrete-Time Signal Processing, 3rd Edition, Pearson Education, New Delhi, 2010.

3. Mitra, S. K., Digital Signal Processing: A Computer-Based Approach, 4th Edition, McGraw-Hill Education, New Delhi, 2013.

4. Sonka, M., Hlavac, V., and Boyle, R., Image Processing, Analysis, and Machine Vision, 4th Edition, Cengage Learning, Boston, 2015.

5.

References:

1. Proakis, J. G. and Manolakis, D. G., Digital Signal Processing: Principles, Algorithms, and Applications, 4th Edition, Pearson Education, 2007.

2. Mallat, S., A Wavelet Tour of Signal Processing: The Sparse Way, 3rd Edition, Academic Press (Elsevier), 2009.

3. Szeliski, R., Computer Vision: Algorithms and Applications, 2nd Edition, Springer, 2022.

4. Pratt, W. K., Digital Image Processing: PIKS Scientific Inside, 4th Edition, John Wiley & Sons, 2007.

PaperCode: ICT 511	Paper: Scientific Writing
Paper ID:	
The evaluation shall be conducted by the concerned teacher (NUES)	

Course Outcomes (CO):

CO 1	To understand the structure of a scientific paper or document
CO 2	Ability to use latex as a manuscript preparation tool.
CO 3	To understand the criterion of evaluation of manuscript by a reviewer
CO 4	To understand the ethical issues in scientific work reporting.

CO vs PO:

	PO1	PO2	PO3	PO4
CO 1	-	3	-	3
CO 2	-	3	-	3
CO3	-	3	-	3
CO4	-	3	-	3

UNIT-I

Why write a scientific manuscript. Structure of a manuscript: Abstract, Introduction, Materials and Methods, Results, and Discussions and its variations. Language.

UNIT-II

Learning to use latex as a text formatting tool. Book, article, report and presentation classes. Standard symbols, equations, tables and figures in latex. Bibliography management using bibtex/natbib.

UNIT-III

Choosing a journal and methods of submission, predatory journals, DOI, ORCID, Manuscript submission and tracking, Types of manuscript. Checklist for manuscript submission. Revision of an article and dealing with rejection.

UNIT-IV

Referencing styles. Bibliometric indexes. Research ethics: Citing another publication, Plagiarism and similarity (checking tools). Journal Impact and indices of journal quality. Writing a research proposal. Ethical Dilemmas and etiquettes of scientific publication.

Textbook(s)/Reference(s):

1.Margaret Cargill and Patrick O'Connor, "Writing Scientific Research Articles", 2nd Edition, Wiley-Blackwell, 2013.
2.S.C. Parija and V. Kate (Editors), "Writing and Publishing a Scientific Research Paper", Springer, 2017
3. M. Jay Katz, "From Research to Manuscript," Springer, 2009
4. P. A. Laplante, "Technical Writing: A Practical Guide for Engineers and Scientists", CRC Press, 2012
5. G. Gratzer, "Practical Latex", Springer, 2014