Pimpri Chinchwad Education Trust's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune

DEPARTMENT OF MECHANICAL ENGINEERING

Curriculum Structure and Syllabus

of

Honor in Computational Intelligence

(Approved by BoS Mechanical Engineering)

(Course 2020)

Effective from Academic Year 2023-24

Institute Vision

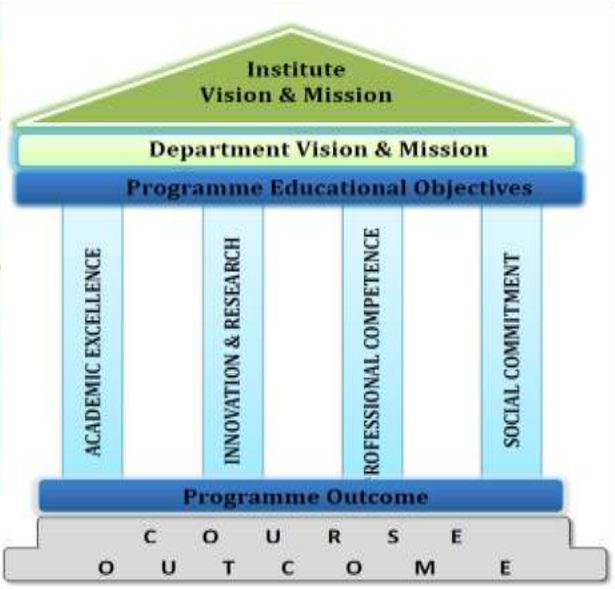
To be one of the top 100 Engineering Institutes of India in coming five years by offering exemplarily Ethical, Sustainable and Value Added Quality Education through a matching ecosystem for building successful careers..

Institute Mission

1. Serving the needs of the society at large through establishment of a state-of-art Engineering Institute.
2. Imparting right Attitude, Skills, Knowledge for self-sustenance through Quality Education.
3. Creating globally competent and Sensible engineers, researchers and entrepreneurs with ability to think and act independently in demanding situations.

Quality Policy

We at PCCOE are committed to impart Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders. We shall strive for academic excellence, professional competence and social commitment in fine blend with innovation and research. We shall achieve this by establishing and strengthening state-of-the-art Engineering and Management Institute through continual improvement in effective implementation of Quality Management System.



Preface

Looking at Global Scenario to enhance the employability skills and impart deep knowledge in emerging/ multidisciplinary areas, an additional avenue is provided to passionate learners through the Minors and Honors Degree Scheme in academic structure.

For Honors degree program, student has to earn additional 20 credits in emerging area of one's own domain.

Objectives of Honors Degree

- To enable students to pursue allied academic interest in contemporary areas.
- To provide effective yet flexible options for students to achieve basic to intermediate level competence in the contemporary area.
- To enhance the employability skills with different combinations of competencies and flavors.
- To provide an academic mechanism for fulfilling demand of specialized areas from industries for higher order skill jobs.
- To provide a strong foundation to students aiming to pursue research/ higher studies in the Contemporary field of study.

Preface of Honor in Computational Intelligence

In view of Industry 4.0, the mechanical Industry has seen disruptive changes and undergoing major value additions in emerging technologies like machine learning, artificial learning, soft computing, digital manufacturing, mechatronics, robotics, etc.

AI has created a paradigm shift in some of the mechanical engineering fields like Complex CAD and CAE using AI, Artificial Neural Networks (ANN) in CFD, IoT and Data Analysis. Artificial Intelligence incorporates Machine Learning that uses statistical methods to allow machines to improve with experiences; we called it predictive experience or maintenance.

This Honors course provides an introduction to the fundamentals of Artificial intelligence and Machine learning, Soft Computing, Intelligence and Optimization. The Students will learn how to use Computational Intelligence methods such as Fuzzy logic, ANN, SWARM Analysis, Revolutionary Computing in Mechanical Domain. These topics are covered and implemented for Mechanical and multidisciplinary systems using state of the art software facilities and hands on. The main focus is on identification, selection and application of suitable computational tool to construct the solution of problem in complex processes and systems.

Course Objectives

The course aims to:

- Introduce the concepts of Artificial intelligence and Machine learning
- Provide the student with the basic understanding of soft computing techniques such as neural networks, fuzzy systems, genetic algorithms and their hybrids
- Hands on experience to develop an AI & ML algorithms with coding exposure
- Exhibit strong professional skills to function effectively in multi-disciplinary areas with a growth mindset.

Course Outcomes:

At the successful completion of this Minor program, students will be able to:

- Identify areas in mechanical domain where computational intelligence tools can be used.
- Write AI & ML algorithms and programming using python, or Matlab or relevant tools and programming languages.
- Identity, select and apply a suitable computational intelligence tools to solve problems in complex process and systems.
- Identify recent developments of computational methods
- Explore opportunities and career in Computational intelligence domain.

INDEX

LIST OF ABBREVIATIONS IN CURRICULUM STRUCTURE

Sr. No.	Abbreviation	Type of Course
1.	L	Lecture
2.	P	Practical
3.	T	Tutorial
4.	H	Hours
5.	CR	Credits
6.	IE1	Internal Evaluation 1
7.	IE2	Internal Evaluation 2
8.	ETE	End Term Evaluation
9.	TW	Term Work
10.	OR	Oral
11.	PR	Practical
12.	PROJ	Project

CREDIT DISTRIBUTION: SEMESTER WISE						
1 Lecture hour = 1 Credit 2 Lab Hours = 1 Credit 1 Tutorial Hour = 1 Credit						
Sr. No.	**Course Title**	**Credits/Semester**				
		5	**6**	**7**	**8**	Total
1.	Introduction to Computational Intelligence	3	0	0	0	3
2.	Introduction to Computational Intelligence Lab	1	0	0	0	1
3.	Soft Computings	0	4	0	0	4
4.	Soft Computing Lab	0	1	0	0	1
5.	Intelligence and Optimization	0	0	3	0	3
6.	Intelligence and Optimization Lab	0	0	1	0	1
7.	Seminar/ Mini-Project/ Internship	0	0	2	0	2
8.	Integrated Project	0	0	0	5	5
	Total	**4**	**5**	**6**	**5**	**20**

Curriculum structure

COMPUTATIONAL INTELLIGENCE

Honors in Mechanical Engineering

Curriculum structure

COMPUTATIONAL INTELLIGENCE

Honor in Mechanical Engineering

Semester	Course Code	Course Name	Teaching Scheme					Evaluation Scheme						
			L	P	T	H	CR	IE	MTE	ETE	TW	PR	OR	Total
V	HME5975	Introduction to Computational Intelligence	3	-	-	3	3	20	30	50		-	-	100
V	HME5976	Introduction to Computational Intelligence Lab	-	2	-	2	1	-	-	-	25	-	-	25
VI	HME6975	Soft Computing	3	-	1	4	4	20	30	50	-	-	-	100
VI	HME6976	Soft Computing Lab	-	2	-	2	1	-	-	-	50	-	-	50
VII	HME7972	Intelligence and Optimization	3	-	-	3	3	20	30	50	-	-	-	100
VII	HME7973	Intelligence and Optimization Lab	-	2	-	2	1	-	-	-	25	-	-	25
VII	HME7974	Seminar/ Mini-Project/ Internship	-	4	-	4	2	-	-	-	-	-	50	50
VIII	HME8978	Integrated Project	-	10	-	10	5	50	-	-	50	-	50	150
			9	20	1	30	**20**	110	90	150	150	-	100	**600**

Abbreviations are: L-Lecture, P-Practical, T-Tutorial, H- Hours, IE- Internal Evaluation, MTE- Mid Term Evaluation, ETE- End Term Evaluation, TW –Termwork, PR-Practical, OR - Oral

Course Syllabus

COMPUTATIONAL INTELLIGENCE

Semester - V

Program:	Honor in Computational Intelligence					Semester: V	
Course:	Introduction to Computational Intelligence					Code: HME5975	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Hours	Credit	IE	MTE	ETE	Total
3	-	3	3	20	30	50	100

Prior knowledge of:

a. Basics of probability and statistics
b. Fundamentals of Mechanical Engineering
c. Fundamentals of mechanical engineering……..are essential

Course Objectives:

1. To provide a strong foundation on fundamental concepts in Computational Intelligence.
2. To enable Problem-solving through various searching techniques.
3. To apply these techniques in applications that involves perception, reasoning and learning.
4. To apply Computational Intelligence techniques for information retrieval
5. To apply Computational Intelligence techniques primarily for machine learning.

Course Outcomes:

The students will be able to,

1. Explain the basics of computational intelligence with their applications in mechanical engineering.
2. Demonstrate the applications of artificial intelligence and machine learning.
3. Apply suitable feature extraction technique and select significant features.
4. Develop classification and regression model for a given mechanical engineering data set.
5. Evaluate the performance of the machine learning models and optimize the model

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Introduction to Computational Intelligence** History, intelligence machine, man-machine interaction, data mining for IoT, Relation between AI, ML, DL, data science and CI. Types of data analytics – predictive, prescriptive, descriptive, and diagnostic; Big data; Web scrapping.	6
2	**Artificial Intelligence in Mechanical Engineering** Concept, Need of AI in Mechanical Engineering, Approaches to AI: Cybernetics and brain simulation, Symbolic, Sub-symbolic, Statistical. **Basics:** Reasoning, problem-solving, Knowledge Representation, Planning, Learning, Perception, Motion, and manipulation.	6
3	**Machine Learning in Mechanical Engineering** Definition of ML, Need of ML in Mechanical Engineering, Approaches to ML: Supervised learning, Unsupervised learning, Reinforcement learning. Mechanical Engineering applications	6
4	**Feature Extraction and Selection** **Feature extraction:** Statistical features, Principal Component Analysis. **Feature selection:** Ranking, Decision tree - Entropy reduction and information gain, Exhaustive, best first, Greedy forward & backward, Applications.	6
5	**Classification and Regression Models** **Classification Models -** Random Forest, Logistic Regression, decision tree, Support Vector Regression, K-Nearest Neighbor (KNN), K-Means, Naive Bayes. **Regression Models -** Linear regression, Ridge regression, neural network regression, Lasso regression, Gaussian regression, and polynomial regression. Overfitting and underfitting	13
6	**Development of ML Model** Problem identification: classification, clustering, regression, ranking. Steps in ML modeling, Data Collection, Data pre-processing, Model Selection, Model training (Training, Testing, K-fold Cross Validation), Model evaluation: confusion matrix, Accuracy, Precision, Recall, True positive, false positive, etc., Hyper parameter Tuning, Predictions.	8
	Total	45

Text Books:

1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
3. Parag Kulkarni and Prachi Joshi, “Artificial Intelligence – Building Intelligent Systems”, PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015
4. Stuart Russell and Peter Norvig (1995), “Artificial Intelligence: A Modern Approach,” Third edition, Pearson, 2003.

Reference books:

1. Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018.
2. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
4. Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)
5. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH

Program:	Honor in Computational Intelligence					Semester: V		
Course:	Introduction to Computational Intelligence Lab					Code: HME5976		
Teaching Scheme				Evaluation Scheme				
Lecture	Practical	Hours	Credit	IE	MTE	ETE	TW	Total
-	2	2	1	-	-	-	25	25

Prior knowledge of:

a. Basics of probability and statistics
b. Fundamentals of Mechanical Engineering
c. Fundamentals of mechanical engineering…….are essential

Course Objectives:

1. To impart a basic understanding of artificial intelligence, machine learning, and deep learning and data science.
2. To make the learner aware of machine learning methods in modeling.
3. To be able to select suitable data collection and preprocessing techniques.
4. To apply techniques for model development and evaluation.

Course Outcomes:

The students will be able to,

1. Understand the relationship between artificial intelligence, machine learning, and deep learning and data science.
2. Use supervised/ unsupervised/ reinforcement learning method.
3. Analyze the data set and Select suitable select suitable features using suitable approach.
4. Evaluate its performance using random forest/ Logistic regression/ Decision tree/ Support vector machine/ K-Nearest Neighbor (KNN)/ K-means/ Naive Bayes.
5. Evaluate its performance regression model.
6. Develop Machine learning model

Detailed Syllabus: (24 Hours)

Miniature commitment or Assignments:

Group A – Any four assignments for a data set using a suitable software package/ programming language

1. A case study on the relationship between artificial intelligence, machine learning, and deep learning and data science.
2. To study supervised/ unsupervised/ reinforcement learning
3. To acquire, visualize and analyze the data set (from time-domain/ frequency-domain/ etc.).
4. To extract features from a given data set and select suitable features using suitable approach
5. To use PCA for dimensionality reduction.
6. To classify features/ develop classification model and evaluate its performance using random forest/ Logistic regression/ Decision tree/ Support vector machine/ K-Nearest Neighbor (KNN)/ K-means/ Naive Bayes.
7. To develop regression model and evaluate its performance (any one algorithm).
8. Machine learning model development and optimization

Group B (Mandatory)

One mini project (in a group of 3-4 students) based on the above contents and using mechanical engineering application dataset.

Text Books:

1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
3. Parag Kulkarni and Prachi Joshi, “Artificial Intelligence – Building Intelligent Systems”, PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015
4. Stuart Russell and Peter Norvig (1995), “Artificial Intelligence: A Modern Approach,” Third edition, Pearson, 2003.

Reference books:

1. Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018.
2. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
4. Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)
5. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH

Course Syllabus

COMPUTATIONAL INTELLIGENCE

Semester - VI

Program:	Honor in Computational Intelligence						Semester: VI		
Course:	Soft Computing						Code: HME6975		
Teaching Scheme				Evaluation Scheme					
Lecture	Tutorial	Hours	Credit	IE	MTE	ETE	TW	OR	Total
3	1	4	4	20	30	50	-	-	100

Prior knowledge of:

a. Some basic familiarity with probability theory and statistics
b. Introduction to computational intelligence
c. Fundamentals of mechanical engineering……..are essential

Course Objectives:

1. To explain the concept of soft computing techniques with their applications in product design. Manufacturing and operations with case studies
2. To expose students to the concept of fuzzy logic and their applications in mechanical system.
3. To familiarize the deep learning model development using artificial neural network.
4. To introduce the concept of genetic algorithm and various advanced algorithms.
5. To apply Markov models for system and process modeling and optimization

Course Outcomes:

The students will be able to,

1. Explain the soft computing techniques with their applications in mechanical engineering.
2. Apply soft fuzzy logic approach for solving different problems in absence of sufficient data and using expert judgments.
3. Develop deep learning model using artificial neural network.
4. Apply genetic algorithms other random search procedures useful while seeking global optimum in self learning situations.
5. Develop Markov models for modeling systems and processes.
6. Apply reinforcement and deep learning models for different data sets and optimize the system performance.

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Introduction to soft computing** Soft computing and its usefulness, Concept of computing systems, soft vs hard computing, characteristics of soft computing, some applications of soft computing techniques	10
2	**Fuzzy Systems** Fuzzy set theory: Fuzzy sets, Operations, Membership Functions, Fuzzy relations and their composition, Measures, Rules, Propositions, Implications, and inferences, Defuzzification techniques, Logic controller design, Some applications of fuzzy logic.	10
3	**Artificial Neural Network (ANN)** Neuron, Nerve structure and synapse, Biological and artificial neurons, Architectures – single layer and multilayer feed forward networks, recurrent networks. Back propagation algorithm, Working principle, Types of ANN, Activation functions – linear, Sigmoid, Tanh, supervised and unsupervised learning, Training techniques for ANNs, Applications, advantages, and limitations.	10
4	**Genetic Algorithms (GA)** Basic Genetics, Concepts, Working Principle, Creation of Offspring, Encoding, Fitness Function, Selection Functions, Genetic Operators-Reproduction, Crossover, Mutation; Genetic Modeling, Advantages, limitations and applications, Comparison between GA and traditional algorithms	10
5	**Markov Models** Markov decision process; Types – discrete and continuous; States of the systems; State transitions; Markov diagram; Semi-Markov chains; Hidden Markov chains; Applications in Mechanical Engineering.	10
6	**Reinforcement Learning (RL) and Deep Learning** What is reinforcement learning? Terms used; Key features; Working process; Approaches – value-based, policy-based, and model-based; Elements – policy, reward signal, value function, model of the environment; The Bellman equation; Types – positive and negative; RL algorithms; Q-learning; Comparison between RL and supervised learning.	10
	Total	60

Text Books:

1. Neural Networks: A Comprehensive Foundation by S. Haykin, Pearson.
2. Fuzzy Logic with Engineering Application by T. J. Ross, John Wiley and Sons.
3. Evolutionary Computation by D.B. Fogel, IEEE Press.
4. D. K. Pratihar, Soft Computing, Narosa Publishing House, 2008.
5. An Introduction to Genetic Algorithm Melanic Mitchell (MIT Press).

Reference books:

1. Evolutionary Algorithm for Solving Multi-objective, Optimization Problems (2nd Edition), Collelo, Lament, Veldhnizer (Springer).
2. Fuzzy Logic with Engineering Applications Timothy J. Ross (Wiley).
3. Neural Networks and Learning Machines Simon Haykin (PHI).
4. Sivanandam, Deepa, Principles of Soft Computing, Wiley.
5. Jang J.S.R, Sun C.T. and Mizutani E, "Neuro-Fuzzy and soft computing", Prentice Hall.
6. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", McGraw Hill.

Tutorials (to be performed in a group of 3-4 students)

1. Applications of soft computing techniques.
2. Concept of Fuzzy relations and their composition.
3. Some applications of fuzzy logic..
4. Applications of ANNs to solve some real life problems
5. Genetic Modeling
6. Applications of Generic Algorithm.
7. Markov chains
8. Applications Markov chains in Mechanical Engineering.
9. Reinforcement Learning
10. Deep Learning.

Program:	Honor in Computational Intelligence						Semester: VI		
Course:	Soft Computing Lab						Code: HME6976		
Teaching Scheme				Evaluation Scheme					
Lecture	Practical	Hours	Credit	IE	MTE	ETE	TW	OR	Total
-	2	2	1	-	-	-	50	-	50

Prior knowledge of:

a. Some basic familiarity with probability theory and statistics
b. Introduction to computational intelligence
c. Fundamentals of mechanical engineering…….are essential

Course Objectives:

1. To explain the difference between soft computing and hard computing
2. To familiarize students with fuzzy logic and its application in Mechanical Domain.
3. To be able model identification / tuning of Control Algorithms.
4. To study Genetic algorithm for optimization of multi-dimensional function / path planning in robotics.
5. To impart a basic understanding of Markov process for modeling manufacturing processes
6. To introduce the concept of Reinforcement learning and deep learning.

Course Outcomes:

The students will be able to,

1. To apply fuzzy logic in mechanical engineering application.
2. Identify the model of NN Control Algorithms.
3. Use and Apply Genetic algorithm for optimization of multi-dimensional function.
4. Use the Markov process for modeling manufacturing processes.
5. Use reinforced models for product performance analysis.
6. Use deep learning models for product performance analysis.

Detailed Syllabus: (24 Hours)

Miniature commitment or Assignments:

Group A – Any four assignments for a data set using a suitable software package/ programming language

1. Comparison between soft computing and hard computing
2. Application of fuzzy logic in mechanical engineering
3. NN for parameter and model identification / tuning of Control Algorithms.
4. Genetic algorithm for optimization of multi-dimensional function / path planning in robotics
5. Markov process for modeling manufacturing processes
6. Reinforcement learning for optimization engineering design/ robot guidance and navigation
7. Deep learning

Group B (Mandatory)

One mini project (in a group of 3-4 students) based on the above contents and using mechanical engineering application dataset.

Text Books:

1. Neural Networks: A Comprehensive Foundation by S. Haykin, Pearson.
2. Fuzzy Logic with Engineering Application by T. J. Ross, John Wiley and Sons.
3. Evolutionary Computation by D.B. Fogel, IEEE Press.
4. D. K. Pratihar, Soft Computing, Narosa Publishing House, 2008.
5. An Introduction to Genetic Algorithm Melanic Mitchell (MIT Press).

Reference books:

1. Evolutionary Algorithm for Solving Multi-objective, Optimization Problems (2nd Edition), Collelo, Lament, Veldhnizer (Springer).
2. Fuzzy Logic with Engineering Applications Timothy J. Ross (Wiley).
3. Neural Networks and Learning Machines Simon Haykin (PHI).
4. Sivanandam, Deepa, Principles of Soft Computing, Wiley.
5. Jang J.S.R, Sun C.T. and Mizutani E, “Neuro-Fuzzy and soft computing”, Prentice Hall.
6. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, McGraw Hill.

Course Syllabus

COMPUTATIONAL INTELLIGENCE

Semester - VII

Program:	Honor in Computational Intelligence					Semester: VII		
Course:	Intelligence and Optimization					Code: HME7972		
Teaching Scheme				Evaluation Scheme				
Lecture	Practical	Hours	Credit	IE	MTE	ETE	TW	Total
3	-	3	3	20	30	50	-	100

Prior knowledge of:

a. Probability and statistics; Numerical Methods and Optimization;
b. Computational Intelligence; Soft computing
c. Fundamentals of mechanical engineering……..are essential

Course Objectives:

1. To explain evolutionary Computing Methods available.
2. To familiarize students with different swarm optimization methods such as colony algorithms, and particle swarm algorithms.
3. To introduce the concept of probabilistic approach in design and design the components using stress-strength distributions.
4. To learn digital image fundamentals and exposed to simple image processing techniques for quality control.
5. To understand various intelligence application in mechanical and allied engineering domains.

Course Outcomes:

The students will be able to,

1. Explain various evolutionary computing methods.
2. Apply different swarm optimization techniques to solve mechanical engineering problems.
3. Design components using probabilistic approach and stress-strength distributions.
4. Apply various image processing techniques to solve quality control problems
5. Develop optimization and search algorithms using Particle-swarm intelligence and AL oriented designs
6. Explain applications of intelligence and optimization techniques in different domains of mechanical engineering.

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Evolutionary Computing Methods:** Principles of Evolutionary Processes and genetics, A history of Evolutionary computation and introduction to evolutionary algorithms, Genetic algorithms, Evolutionary strategy, Evolutionary programming, Genetic programming.	7
2	**Swarm Intelligence and Optimization** Concept of swarm optimization; features; types algorithms - Ant colony optimization (ACO), Particle swarm optimization (PSO), Artificial Bee colony algorithm (ABC), Other variants of swarm intelligence algorithms; Parameter selection; Applications.	8
3	**Probabilistic Approach in Mechanical System Design** Stress-Strength Models; Functions of random variables; Probabilistic design; Steps involved probabilistic design; Probability distributions; Hazard rate models – decreasing, constant, and increasing; Safety; variability; and reliability; Physics of failure.	7
4	**Image Processing for Metrology and Quality Control** Overview, Computer imaging systems; Image Analysis, Preprocessing, Human vision system, Image model, Image enhancement, grey scale models, histogram models, Image Transforms – Examples.	8
5	**Applications** Human Machine Interaction, Predictive Maintenance and Health Management, Fault Detection, Dynamic System Order Reduction, Image based part classification, Process Optimization, Material Inspection, Tuning of control algorithms.	7
6	**Case Studies** Thermal/ Heat transfer/ HVAC/ Fluid Mechanics/ Fluid Power; Solid mechanics/ Design; Machining/ Manufacturing/ Automation & robotics; Reliability/ maintenance/ condition monitoring; Quality control; Materials & metallurgy; Energy conservation & management; Industrial engineering, estimation, and costing.	8
	Total	45

Text Books:

1. Tettamanzi Andrea, Tomassini and Marco, Soft Computing Integrating Evolutionary, Neural and Fuzzy Systems, Springer, 2001.
2. Ashish M. Gujarathi, B. V. Babu," Evolutionary Computation: Techniques and Applications",CRC Press 2016.
3. Kalyanmoy Deb, Multi-objective Optimization using Evolutionary Algorithms, John Wiley and Sons, 2001.
4. Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Third Edition, Pearson Education, 2010. Elaine Rich, Artificial Intelligence, McGraw Hill, 2/e, 1990.

Reference books:

1. X. Yao," Evolutionary Computation: Theory and Applications", World Scientific Publ. Co., Singapore, 1999.
2. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.
3. Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2011.

Program:	Honor in Computational Intelligence					Semester: VII		
Course:	Intelligence and Optimization Lab					Code: HME7973		
Teaching Scheme				Evaluation Scheme				
Lecture	Practical	Hours	Credit	IE	MTE	ETE	TW	Total
-	2	2	1	-	-	-	25	25

Prior knowledge of:

a. Probability and statistics; Numerical Methods and Optimization;
b. Computational Intelligence; Soft computing
c. Fundamentals of mechanical engineering……..are essential

Course Objectives:

1. To introduce basic concepts and methods of evolutionary computing methods.
2. To expose students to the Ant colony optimization, Particle swarm optimization, Artificial Bee colony algorithm
3. To impart the basic understanding of Probabilistic approach in mechanical system design
4. To explain the concept Image processing for metrology and quality control

Course Outcomes:

The students will be able to,

1. Use evolutionary computing methods.
2. Use and apply Ant colony optimization method.
3. Use and apply particle swarm optimization method
4. Use and apply Artificial Bee colony algorithm
5. Use probabilistic approach in mechanical system design.
6. Use Image processing for metrology and quality control.

Detailed Syllabus: (24 Hours)

Miniature commitment or Assignments:

Group A – Any four assignments for a data set using a suitable software package/ programming language

1. Assignment on evolutionary computing methods
2. Ant colony optimization (ACO)
3. Particle swarm optimization (PSO)
4. Artificial Bee colony algorithm (ABC)
5. Probabilistic approach in mechanical system design
6. Image processing for metrology and quality control

Group B (Mandatory)

One mini project (in a group of 3-4 students) based on the above contents and using mechanical engineering application dataset.

Text Books:

1. Tettamanzi Andrea, Tomassini and Marco, Soft Computing Integrating Evolutionary, Neural and Fuzzy Systems, Springer, 2001.
2. Ashish M. Gujarathi, B. V. Babu," Evolutionary Computation: Techniques and Applications",CRC Press 2016.
3. Kalyanmoy Deb, Multi-objective Optimization using Evolutionary Algorithms, John Wiley and Sons, 2001.
4. Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Third Edition, Pearson Education, 2010.
5. Elaine Rich, Artificial Intelligence, McGraw Hill, 2/e, 1990.

Reference books:

1. X. Yao," Evolutionary Computation: Theory and Applications", World Scientific Publ. Co., Singapore, 1999.
2. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.
3. Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2011.

Program:	Honors in Computational Intelligence					Semester: VII	
Course:	Seminar/ Mini-Project/ Internship					Code: HME7974	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Hours	Credit	IE	TW	OR	Total
-	4	4	2	-	-	50	50

Prior knowledge of:

a. Basics of Mechanical Engineering
b. Introduction to Computational Intelligence
c. Soft Computing
d. Intelligence and Optimization……..are essential

Course Objectives:

Students are expected to study,

1. Applications of different computational intelligence and optimization techniques at different life cycle phases of the system/ product.
2. Case studies based on the various phases in system design, analysis, and implementation of real-time applications/ case study using available platforms.

Course Outcomes:

The students will be able to,

1. Understand, plan, and execute a Seminar/ Mini-Project/ Internship.
2. Conduct a case study based on the real-time data/ laboratory data
3. Prepare a technical report based on the Seminar/ Mini-Project/ Internship.
4. Deliver technical presentations based on the work including a case study carried out.
5. Understand publication and copyright process of research

Guidelines: Total: 24 h (contact) + 24 h (non-contact/implementation)

1. Topic for the Seminar/ Mini-Project/ Internship should be selected based on any topics covered in this honors course.
2. It is expected to carry out the Seminar/ Mini-Project/ Internship work at individual level under the guidance of the allocated guide.
3. Students can choose the Seminar/ Mini-Project/ Internship topic considering their implementation in Integrated Project/ Major Project.
4. A case study should be included in the Seminar/ Mini-Project/ Internship. Use of suitable software/ programming language is compulsory.
5. Seminar/ Mini-Project/ Internship report should be submitted in compliance with the term work associated with the subject.
6. Paper publication associated with the project as a research outcome is appreciable.
7. Seminar/ Mini-Project/ Internship work preferably should be completed in the laboratory/ industry.

Contents of the Seminar/ Mini-Project/ Internship report

The Seminar/ Mini-Project/ Internship report includes the following:

- Abstract/Summary
- Introduction: Background, motivation, and Scope
- Literature review: should be based on at least five research papers published during the last 5 years:
- Methodology (if any)
- Case study
- Conclusion
- References

Sr. No.	Activity	Duration (H)
1	Week 1, 2, & 3: Seminar/ Mini-Project/ Internship guide allotment, Finalization of topic and platform, Planning of the work, Literature review, identifying a problem, and formulating the problem for the Seminar/ Mini-Project/ Internship.	12
2	Week 4, 5, & 6: Methodology finalization, finalizing project proposal, Review 1 for finalization of topic and specification.	12
3	Week 7, 8, & 9: Data analysis using suitable software/ programming language, Review 2 to understand the progress of the project	12
4	Week 10, 11, & 12: Seminar/ Mini-Project/ Internship report writing, and publication or copyright planning and execution, Submission and term work compliances.	12
	Total	48

Course Syllabus

COMPUTATIONAL INTELLIGENCE

Semester - VIII

Program:	Honor in Computational Intelligence					Semester: VIII	
Course:	Integrated Project					Code: HME8978	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Hours	Credit	IE	TW	OR	Total
-	10	10	5	50	50	50	150

Prior knowledge of:

a. Basics of mechanical engineering
b. Computational Intelligence
c. Soft Computing
d. Intelligence and Optimization……..are essential

Course Objectives:

Students are expected to study,

1. Product design and optimization using computational intelligence
2. Process development and optimization
3. Applications of machine learning and deep learning concepts for mechanical engineering data
4. Various activities are involved in the project and its planning to channelize the work.
5. Building, designing, analysis, and implementation of real-time applications using available platforms.

Course Outcomes:

The students will be able to,

1. Understand, plan and execute a project.
2. Design a real-time application
3. Prepare a technical report based on the project.
4. Deliver technical seminars based on the project work carried out.
5. Understand publication and copyright process of research

Guidelines: Total: 40 h (contact) + 80 h (non-contact/implementation)

1. A group of 3 to 4 students needs to design and demonstrate the project under the guidance of the allocated guide.
2. Students can choose the project considering their implementation in Major Project.
3. The hardware implementation and or software simulation is compulsory.
4. Project Report should be submitted in compliance with term work associated with the subject.
5. Paper publication associated with the project as research outcome is appreciable.
6. Project work preferably should be completed in the laboratory/ industry.

Detailed Syllabus

Sr. No.	Activity	Duration (H)
1	Semester VIII (week 1 & 2): Project guide allotment, Finalization of topic and platform, Planning of the work, Literature review, identifying a problem, and formulating the problem for the project	20
2	Semester VIII (week 3 & 4): Methodology finalization, finalizing project proposal, Review 1 for finalization of topic and specification.	20
3	Semester VIII (week 5 & 6): Simulation of Ideas on appropriate software tools and finalization of hardware platform	20
4	Semester VIII (week 7 & 8): Understanding platform implementation and related software flow and execute the block-level design, Review 2 to understand the progress of the project	20
5	Semester VIII (week 9 & 10): Project Report writing and publication or copyright planning and execution.	20
6	Semester VIII (week 11 & 12): Demonstration of Project work and Final Review for submission and term work compliances.	20
	Total	120