Indian Institute of Technology Guwahati

School of Interdisciplinary Studies in Advanced Sciences (SiSAS)

Programme Curriculum

Online M.Tech. in Robotics and Artificial Intelligence

Total Credits: 108 | Duration: 2 Years | 6 Terms

YEAR 1

Year 1 | Term 1 | August/September – November/December

Course Code	Course Name	Credit Structure (L-T-P-C)
SSO5201	Fundamentals of Robotics	3-0-0-6
SSO5202	Artificial Intelligence	2-0-2-6
SSO5203	Robot Sensing and Vision	3-0-0-6
	Total Credits	**18**

Year 1 | Term 2 | January/February – April/May

Course Code	Course Name	Credit Structure (L-T-P-C)
SSO5204	Machine Learning	3-0-0-6
SSO52XX	Elective 1	3-0-0-6
SSO52XX	Elective 2	3-0-0-6
	Total Credits	**18**

Year 1 | Term 3 | May/June – July/August

Course Code	Course Name	Credit Structure (L-T-P-C)
SSO52XX	Elective 3	3-0-0-6
SSO52XX	Elective 4	3-0-0-6
SSO52XX	Elective 5	3-0-0-6
	Total Credits	**18**

YEAR 2

Year 2 | Term 1 | August/September – November/December

Course Code	Course Name	Credit Structure (L-T-P-C)
SSO52XX	Elective 6	3-0-0-6
SSO5297	Capstone Project Phase-I	0-0-12-12
	Total Credits	**18**

Year 2 | Term 2 | January/February – April/May

Course Code	Course Name	Credit Structure (L-T-P-C)
SSO5298	Capstone Project Phase-II	0-0-18-18
	Total Credits	**18**

Year 2 | Term 3 | May/June – July/August

Course Code	Course Name	Credit Structure (L-T-P-C)
SSO5299	Capstone Project Phase-III	0-0-18-18
	Total Credits	**18**

Programme Summary

Year	Term	Content	Credits
Year 1	Term 1 (Aug–Nov)	3 Core Courses	**18**
Year 1	Term 2 (Jan–Apr)	1 Core + 2 Electives	**18**
Year 1	Term 3 (May–Jul)	3 Electives	**18**
Year 2	Term 1 (Aug–Nov)	1 Elective + Capstone Phase-I	**18**
Year 2	Term 2 (Jan–Apr)	Capstone Project Phase-II	**18**
Year 2	Term 3 (May–Jul)	Capstone Project Phase-III	**18**
		Total Programme Credits	**108**

Credit Structure notation: L – Lectures | T – Tutorials | P – Practicals/Project Hours | C – Total Credits

Course Syllabi

Online M.Tech. in Robotics and Artificial Intelligence — Core Courses

SSO5201	**Fundamentals of Robotics**	3-0-0-6

Course Content

Introduction to Robotics: Types and classification of robots; science and technology of robots; Rigid Body Transformation: Overview of rigid body kinematics; homogeneous transformation; link transformation matrices; Forward and Inverse Kinematics and Dynamics of Robots; Planning and Control of Robots.

Textbooks

1. Fu K.S., Gonzalez R.C. and Lee C.S.G., Robotics: Control, Sensing, Vision and Intelligence, Tata McGraw Hill, 2008.
2. Ghosal A., Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2006.
3. Craig J.J., Introduction to Robotics – Mechanics and Control, Pearson Prentice Hall, 2005.
4. Murray R., Li Z. and Sastry S., A Mathematical Introduction to Robot Manipulation, CRC Press, 1994.

References

1. Spong M.W., Hutchinson S. and Vidyasagar M., Robot Modeling and Control, John Wiley & Sons Inc., 2005.
2. Saha S.K., Introduction to Robotics, McGraw Hill Education (India) Private Limited, 2014.

SSO5202	**Artificial Intelligence**	2-0-2-6

Course Content

Introduction; Searching Techniques: uninformed search strategies, informed (heuristic) search strategies, local search algorithms, searching in non-deterministic and partially observable environment, adversarial search, Temporal Probability models and inference in temporal models: filtering, prediction, smoothing, most likely explanation, Dynamic Bayesian Networks, Hidden Markov Model, Kalman Filter, Extended Kalman Filter, Particle Filter, Learning Probabilistic Models; Decision making: Markov Decision Processes (MDPs), Partially Observable MDPs (POMDPs); Learning: Introduction to supervised learning, unsupervised learning, and reinforcement learning.

Textbooks

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition, Pearson, 2014.

References

1. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. C. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
3. R.S. Sutton and A.G. Barto, Reinforcement Learning: An Introduction, 2nd Edition, MIT Press, 2018.

SSO5203	Robot Sensing and Vision	3-0-0-6

Course Content

Robotic vision sensors and their interfacing; Fundamentals of Computer Vision: Image accusation and representation, image transformation, filtering, restoration, morphing, Camera Models, Calibration, Single view geometry, Multiple view geometry, Epipolar geometry, RANSAC; Position and Orientation: Feature based alignment; Pose estimation; Time varying pose and trajectories, Structure from motion, dense Motion Estimation, Visual Odometry (Semi-direct VO, direct sparse odometry), Bundle Assignment; Localization and Mapping: Initialization, Tracking, Mapping, geometric SLAM formulations (indirect vs. direct error formulation, geometry parameterization, sparse vs. dense model, optimization approach), Relocalization and map Optimization, Visual SLAM, Examples: Indirect (Feature based) methods (MonoSLAM, PTAM, ORB-SLAM), Direct methods (DTAM, LSD-SLAM), Sensor combinations (IMU, mono vs. Stereo, RGB-Depth), Analysis and parameter studies; Recognition and Interpretations: Concepts of machine learning and deep learning, sequence modeling, Learning for robotic vision: Active learning, incremental and class incremental learning identify unknowns, uncertainty estimation, Embodiment for robotic vision: active vision, spatial and temporal embodiment, reasoning for object, scene and scene semantics.

Textbooks

1. H. R. Everett, Sensors for Mobile Robots: Theory and Application, A K Peters/CRC Press, 1995.
2. Dahiya R.S. and Valle M., Robotic Tactile Sensing, Springer, 2013.
3. S.R. Deb and Sankha Deb, Robotics Technology and Flexible Automation, 2nd Edition, McGraw Hill Education, 2017.
4. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis and Machine Vision, Cengage, 3rd Edition, 2013.
5. Abdessalan Bouzerdoum, George Mamic and M. Bennamoun, Object Recognition: Fundamentals & Case Studies, First Edition, Universities Press, 2008.
6. Abdulmajeed Wael, Mansoor Revan, Visual Robot Slam of 2D & 3D Indoor Environment, LAP Lambert Academic Publishing, 2014.

Reference Books

1. Buduma N., Fundamentals of Deep Learning, Designing Next-Generation Artificial Intelligence Algorithms, O'Reilly Media, June 2015.
2. D. A. Forsyth and J. Ponce, Computer Vision, A Modern Approach, Pearson Education, 2003.
3. D. H. Ballard and C. M. Brown, Computer Vision, Prentice Hall, 1982.

SSO5204	Machine Learning	3-0-0-6

Course Content

Introduction to supervised and unsupervised learning frameworks; Dimensionality reduction: Feature selection; PCA; Supervised learning: Bayesian classification, Perceptrons, Multi-layer perceptron, RBF Networks, Decision Trees, Support Vector Machines, Convolutional Neural Networks, Recurrent Neural Networks; Unsupervised learning: K-Means clustering, DBSCAN, Non-parametric Estimation, Mean-shift clustering; Classification performance analysis; Ensemble methods - Boosting and Bagging; Applications and Case Studies in Robotics.

Textbooks

1. E. Alpaydin, Introduction to Machine Learning, 3rd Edition, Prentice Hall (India), 2015.
2. R.O. Duda, P.E. Hart and D.G. Stork, Pattern Classification, 2nd Edition, Wiley India, 2007.
3. C.M. Bishop, Pattern Recognition and Machine Learning (Information Science and Statistics), Springer, 2006.
4. S.O. Haykin, Neural Networks and Learning Machines, 3rd Edition, Pearson Education (India), 2016.
5. Goodfellow, Y. Bengio and A. Courville, Deep Learning, MIT Press, 2017.

Prospective Elective Courses

1. Deep Learning
2. CAD/CAM
3. Cybersecurity for Connected and Intelligent Systems
4. Mobile Robotics
5. Intelligent Cyber-Physical Systems
6. Additive Manufacturing Technologies
7. Semiconductor Materials to Chips
8. Introduction to Natural Language Processing
9. Optimization Techniques for AI/ML
10. Geo Spatial Data Structure