MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB

(Formerly West Bengal University of Technology)

Syllabus for B. Sc. In Robotics& 3D Printing (In-house)
(Effective for Students Admitted in Academic Session 2020-2021)
In CBCS Format

4th Semester

`Subject Type			Course Code	Course Name	Credit Points	Credit Distribution			Mode of Delivery		
						Th	Pr	Tu	Offline	Online	Blended
CC	CC 8	CC8.1	RBEE401	Power Electronics and Drives	4	4	0	0	✓	✓	✓
		CC8.2	RBEE491	Power Electronics and Drives Lab	2	0	2	0	✓	✓	✓
	CC9	CC9.1	RBEC401	Sensors and Instrumentation	4	4	0	0	✓	✓	✓
		CC9.2	RBEC491	Sensors and Instrumentation Lab	2	0	2	0	✓	✓	✓
	CC 10	CC10.1	RBPR401	Principles of Robotics I	4	4	0	0	✓	✓	✓
		CC10.2	RBPR491	Principle Robotics Lab I	2	0	2	0	✓	✓	✓
GE		GE 4.1	RBHU401	Values & Ethics*	4	4	0	0	✓	✓	✓
		GE 4.2	RBHUT401	Values & Ethics Tutorial *	2	0	0	2	✓	✓	✓
SEC		SEC1.1	RBCS401	Machine Learning,*	2	2	0	0	✓	✓	✓
	Semester Credits				**26**						

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Semester-IV

Subject: Power Electronics and Drives
Code: RB-EE401
Contact Hours/week: 3L+1T
Credits: 4

OBJECTIVES

- Comprehensive introduction to various power electronic devices, their structure, operating principle and characteristics
- Give exposure to Various topologies, working principle and analysis of controlled rectifiers and ac controllers
- Detailed knowledge on Classifications, structure, operating principle of dc choppers
- Introduction to different types of Inverters , their principle of operation and waveform control
- Overview on dc and ac drives and their control using power electronic circuits.

UNIT I POWER SEMICONDUCTOR DEVICES AND CHARACTERISTICS

Operating principle and switching Characteristics: Power diodes, Power BJT, Power MOSFET, IGBT, SCR, TRIAC, GTO, MCT, Power integrated circuits (PIC) – Drive and Protection circuits – Series and parallel operation – Commutation – Simulation tools.

UNIT II CONTROLLED RECTIFIERS AND AC CONTROLLERS

Single phase – Three phase – Half controlled – Fully controlled rectifiers – Dual converters - Effect of source and load inductance - AC voltage controllers –Introduction to Cycloconverters, Matrix converters.

UNIT III DC TO DC CONVERTERS

Step up and Step down Chopper – Chopper classification - quadrant of operation – Switching mode Regulators – Buck, Boost, Buck-Boost, and Cuk Regulators.

UNIT IV INVERTERS

Voltage source Inverters – Half bridge – Full bridge – Three Phase Bridge Inverters – Voltage control– PWM Techniques – Current Source Inverters: Capacitor Commutated Inverter- Resonant inverters: Series, Parallel, ZVS, ZCS – Introduction to multilevel Inverters.

UNIT V DRIVES AND CONTROL

Static and Dynamic equations of dc and ac machines – Electrical breaking – Rectifier and chopper control of DC drives – Principles of v/f control of AC drives – Open loop and Closed

loop schemes for DC and AC drives(Block diagram approach only) – Introduction to vector control of AC drives.

COURSE OUTCOMES (COs)

1. Ability to explain various devices and their structure, operating characteristics in the field of electronics.
2. Ability to classify, analyze and design, Control rectifier, chopper and inverter.
3. Will have ability to apply power electronic circuits for the control of popular applications.
4. Exposure to design and analyze PE circuit using simulation software.

TEXT BOOKS:

1. Rashid, M.H., "Power Electronics – Circuits, Devices and Applications", PHI, 3rd Edition, 2004.
2. Mohan, Udeland and Robbins., "Power Electronics", John Wiley and Sons, New York, 1995.

REFERENCES:

1. Singh, M.D., and Khanchandani, K.B., "Power Electronics", 2nd Edition., Tata McGraw-Hill, 2011.
2. Bose, B.K., "Modern Power Electronics and AC Drives", Pearson Education, 2002.
3. Bimbra, P.S., "Power Electronics", Khanna Publishers, 2006.
4. Moorthi, V.R., "Power Electronics - Devices, Circuits and Industrial Applications", Oxford University Press, 2005.
5. NPTEL Lecture Series on "Power Electronics" by Dr.B.G.Fernandes, IIT Bombay.

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Subject: Power Electronics & Drives Lab
Code: RB-EE491
Contact Hours/week: 3P
Credits: 2

OBJECTIVES:
- To provide hands on experience with power electronic converters and testing.

LIST OF EXPERIMENTS
1 Gate Pulse Generation using R, RC and UJT.
2 Characteristics of SCR and TRIAC
3 Characteristics of MOSFET and IGBT
4 AC to DC half controlled converter
5 AC to DC fully controlled Converter
6 Step down and step up MOSFET based choppers
7 IGBT based single phase PWM inverter
8 IGBT based three phase PWM inverter
9 AC Voltage controller
10 Switched mode power converter.
11 Simulation of PE circuits (1Φ & 3Φ semi converters, 1Φ & 3Φ full converters, DC-DC converters, AC voltage controllers).
12 Characteristics of GTO & IGCT.
13 Characteristics of PMBLDC motor

OUTCOMES:
- Ability to practice and understand converter and inverter circuits and apply software for engineering problems.
- Ability to experiment about switching characteristics various switches.
- Ability to analyze about AC to DC converter circuits.
- Ability to analyze about DC to AC circuits.
- Ability to acquire knowledge on AC to AC converters
- Ability to acquire knowledge on simulation software.

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Syllabus for B. Sc. In Robotics& 3D Printing (In-house)
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In CBCS Format

Subject: Sensors and Instrumentation
Code: RB-EC401
Contact Hours/week: 3L+1T
Credits: 4

OBJECTIVES:
• To understand the concepts of measurement technology.
• To learn the various sensors used to measure various physical parameters.
• To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development.

UNIT I INTRODUCTION

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT II MOTION, PROXIMITY AND RANGING SENSORS

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III FORCE, MAGNETIC AND HEADING SENSORS

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers. UNIT IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS 11 Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT V SIGNAL CONDITIONING AND DAQ SYSTEMS

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

OUTCOMES:
Upon Completion of the course the students will be able to
CO1: Familiar with various calibration techniques and signal types for sensors.
CO2: Apply the various sensors in the Automotive and Mechatronics applications
CO3: Describe the working principle and characteristics of force, magnetic and heading sensors.

CO4: Understand the basic principles of various pressure and temperature, smart sensors.
CO5: Ability to implement the DAQ systems with different sensors for real time applications.

TEXT BOOKS:

1.Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill, 2009 2.Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", 12th edition, Dhanpat Rai & Co, New Delhi, 2013.

REFERENCES

1.C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001
2.Hans Kurt Tönshoff (Editor), Ichiro , "Sensors in Manufacturing" Volume 1, Wiley-VCH April 2001.
3.John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999.
4.Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2011.
5.Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press, 2015

Subject: Sensors & Instrumentation Lab
Code: RB-EC491
Contact Hours/week: 3P
Credits: 2

Laboratory Experiments :

1 Temperature measurement using AD590 IC sensor.

2 Displacement measurement by using a capacitive transducer.

3 Pressure and displacement measurement by using LVDT.

4 Study of a load cell with tensile and compressive load.

5 Torque measurement Strain gauge transducer.

6 Speed measurement using magnetic proximity sensor.

7 Speed measurement using a Stroboscope.

8 Study of the characteristics of a LDR.

9 Mandatory Design and Implementation of Mini Project

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In CBCS Format

Subject: Principles of Robotics I
Code: RBPR401
Contact Hours/week: 3L+1T
Credits: 4

OBJECTIVES:

- To introduce the functional elements of Robotics
- To impart knowledge on the direct and inverse kinematics
- To introduce the manipulator differential motion and control
- To educate on various path planning techniques
- To introduce the dynamics and control of manipulators

UNIT I BASIC CONCEPTS

Brief history-Types of Robot–Technology-Robot classifications and specifications-Design and controlissues- Various manipulators – Sensors - work cell - Programming languages.

UNIT II DIRECT AND INVERSE KINEMATICS

Mathematical representation of Robots - Position and orientation – Homogeneous transformationVarious joints- Representation using the Denavit Hattenberg parameters - Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots- Solvability – Solution methods-Closed form solution.

UNIT III MANIPULATOR DIFFERENTIAL MOTION AND STATICS

Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse - Wrist and arm singularity - Static analysis - Force and moment Balance.

UNIT IV PATH PLANNING

Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.

UNIT V DYNAMICS AND CONTROL

Lagrangian mechanics-2DOF Manipulator-Lagrange Euler formulation-Dynamic model – Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator.

UNIT VI INTRODUCTION TO ROBOTIC PROCESS AUTOMATION & BOT CREATION

Introduction to RPA and Use cases – Automation Anywhere Enterprise Platform – Advanced features and capabilities – Ways to create Bots – Conclusion.

UNIT VII WEB CONTROL ROOM AND CLIENT

Introduction - Features Panel - Dashboard (Home, Bots, Devices, Audit, Workload, Insights) - Features Panel – Activity (View Tasks in Progress and Scheduled Tasks) - Bots (View Bots Uploaded and Credentials) - Devices (View Development and Runtime Clients and Device Pools) - Workload (Queues and SLA Calculator) - Audit Log (View Activities Logged which are associated with Web CR) - Administration (Configure Settings, Users, Roles, License and Migration) - Demo of Exposed API's – Conclusion – Client introduction and Conclusion.

OUTCOMES:

- Ability to understand basic concept of robotics.
- To analyze Instrumentation systems and their applications to various
- To know about the differential motion add statics in robotics
- To know about the various path planning techniques.
- To know about the dynamics and control in robotics industries.

TEXT BOOKS:

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005. 2. JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 3. 2009.
3. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.
4. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath: Create Software robots. with the leading RPA tool – UiPath Kindle Edition
5. Robotic Process Automation A Complete Guide - 2020 Edition Kindle Editio

REFERENCES:

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. K. K.Appu Kuttan, Robotics, I K International, 2007.
3. Edwin Wise, Applied Robotics, Cengage Learning, 2003.
4. R.D.Klafter,T.A.Chimielewski and M.Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India, New Delhi, 1994.
5. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers,Chennai, 1998.
6. S.Ghoshal, " Embedded Systems & Robotics" – Projects using the 8051 Microcontroller", Cengage Learning, 2009.

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Subject: Principle Robotics Lab I
Code: RBPR491
Contact Hours/week: 3P
Credits: 2

OBJECTIVES:
- To introduce different types of robotics and demonstrate them to identify different parts and components.
- To write programming for simple operations.

LIST OF EXPERIMENTS
1. Determination of maximum and minimum position of links.
2. Verification of transformation (Position and orientation) with respect to gripper and world coordinate system 3. Estimation of accuracy, repeatability and resolution.
4. Robot programming and simulation for pick and place
5. Robot programming and simulation for Colour identification
6. Robot programming and simulation for Shape identification
7. Robot programming and simulation for machining (cutting, welding)
8. Robot programming and simulation for writing practice
9. Robot programming and simulation for any industrial process (Packaging, Assembly)
10. Robot programming and simulation for multi process.

OUTCOME:
Upon Completion of the course, the students will be able to:
CO1:Use of any robotic simulation software to model the different types of robots and calculate work volume for different robots

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Subject: Values & Ethics*
Code: RB-HU601
Contact Hours/week: 3L
Credits: 2

OBJECTIVE: • To enable the students to create an awareness on Engineering Ethics and Human Values to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V GLOBAL ISSUES

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

OUTCOME: • Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

TEXT BOOKS: 1. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004. 2. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.

REFERENCES: 1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004. 2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009. 3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003 4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001. 5. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd.,New Delhi, 2013. 6. World Community Service Centre, ' Value Education', Vethathiri publications, Erode, 2011.

Web sources: 1. www.onlineethics.org
2. www.nspe.org
3. www.globalethics.org
4. www.ethics.org

*** Course to be completed from MOOCs Platform.**

Subject: Machine Learning,*
Code:
Contact Hours/week: 3L
Credits: 2
UNIT I-Introduction: Basic denitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation.
UNIT 2-Linear regression, Decision trees, overtting.
UNIT 3-Instance based learning, Feature reduction, Collaborative ltering based recommendation.
UNIT 4- Probability and Bayes learning.
UNIT 5- Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM.
UNIT 6- Neural network: Perceptron, multilayer network, backpropagation, introduction to deep neural network.
UNIT 7- Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning.
UNIT 8- Clustering: k-means, adaptive hierarchical clustering, Gaussian mixture model.