

**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**

**6<sup>th</sup> Semester**

Subject Type			Course Code	Course Name	Credit Points	Credit Distribution			Mode of Delivery		
						Th	P r	Tu	Offline	Online	Blended
CC	CC13	CC13.1	RBPR601	3D Printing	4	4	0	0	✓	✓	✓
		CC13.2	RBPR691	3D Printing Lab	2	0	2	0	✓	✓	✓
	CC14	CC14.1	RBCS601	Machine Vision	4	4	0	0	✓	✓	✓
		CC14.2	RBCS691	Machine Vision Lab	2	0	2	0	✓	✓	✓
DSE		DSE 3.1	RBCS602	Internet of things*	4	4	0	0	✓	✓	✓
		DSE3.2	RBCS692	Internet of things Lab *	2	0	2	0	✓	✓	✓
DSE		DSE 4.1	RBPR692	Project	6	4	0	0	✓	✓	✓
Semester Credits					<b>24</b>						
GRAND TOTAL Credits					<b>140</b>						

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

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**Semester-VI**

**Subject:** 3D Printing

**Code:** RB-PR601

**Contact Hours/week:** 3L+1T

**Credits:** 4

**PRE-REQUISITES**

- Computer Aided Design
- Engineering Materials

**OBJECTIVES**

The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry 4.0 environment.

**LEARNING OUTCOMES**

After completion of this course, the students will be able to:

- Develop CAD models for 3D printing.
- Import and Export CAD data and generate .stl file.
- Select a specific material for the given application.
- Select a 3D printing process for an application.
- Produce a product using 3D Printing or Additive Manufacturing (AM).

**DETAIL CONTENTS**

1. 3D Printing (Additive Manufacturing) (3 Hours)

Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications.

2. CAD for Additive Manufacturing (4 Hours)

CAD Data formats, Data translation, Data loss, STL format.

3. Additive Manufacturing Techniques (12 Hours)

3.1 Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology.

3.2 Process, Process parameter, Process Selection for various applications.

3.3 Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools

4. Materials (8 Hours)

4.1 Polymers, Metals, Non-Metals, Ceramics

4.2 Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties.

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- 4.3 Support Materials
- 5. Additive Manufacturing Equipment (10 Hours)
  - 5.1 Process Equipment- Design and process parameters
  - 5.2 Governing Bonding Mechanism
  - 5.3 Common faults and troubleshooting
  - 5.4 Process Design
- 6. Post Processing: Requirement and Techniques (4 Hours)
- 7. Product Quality (4 Hours)
  - 7.1 Inspection and testing
  - 7.2 Defects and their cause

**Subject: 3D Printing Lab**

**Code: RBPR691**

**Contact Hours/week: 3P**

**Credits: 2**

**LIST OF PRACTICALS**

1. 3D Modelling of a single component.
2. Assembly of CAD modelled Components
3. Exercise on CAD Data Exchange.
4. Generation of .stl files.
5. Identification of a product for Additive Manufacturing and its AM process plan.
6. Printing of identified product on an available AM machine.
7. Post processing of additively manufactured product.
8. Inspection and defect analysis of the additively manufactured product.
9. Comparison of Additively manufactured product with conventional manufactured counterpart.
10. Software Installation Procedure – Installation of AA Control Room, SQL Server and AA Client.
  - Bot Creation using recorders (Smart, Web and Screen ).
  - Bot Creation using command library – (Loop Command).
  - Bot Creation to invoke database automation
  - Bot Creation for automating excel operations
  - Bot Creation for PDF Integrations.
  - Bot Creation and working on error handling.
  - Bot Development using Object Cloning Command.
  - FTP and PGB Command Execution by Bots
  - MetaBot Designing with AI Sense.

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**Subject: Machine Vision**

**Code: RB-CS601**

**Contact Hours/week: 3L+1T**

**Credits: 4**

**OBJECTIVES:**

- To know about the principles and applications of vision system in modern manufacturing environment
- To learn about the algorithms in vision
- To know about the recognition of object
- To be familiar about the applications regarding vision
- To know about the components used for vision

**UNIT I VISION SYSTEM**

Basic Components – Elements of visual perception, Lenses: Pinhole cameras, Gaussian Optics – Cameras – Camera-Computer interfaces

**UNIT II VISION ALGORITHMS**

Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours – Image Enhancement : Gray value transformations, image smoothing, Fourier Transform – Geometric Transformation - Image segmentation – Segmentation of contours, lines, circles and ellipses – Camera calibration – Stereo Reconstruction.

**UNIT III OBJECT RECOGNITION**

Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of dept values.

**UNIT IV APPLICATIONS**

Transforming sensor reading, Mapping Sonar Data, Aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatiograms, K-means Clustering, EM Clustering.

**UNIT V ROBOT VISION**

Basic introduction to Robotic operating System (ROS) - Real and Simulated Robots - Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to OpenCV - The cv\_bridge Package.

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**OUTCOMES:**

- Knowledge of gadgets of vision systems
- Ability to understand the image capturing and processing techniques
- Ability to apply the vision system in other machines
- Knowledge for recognizing the objects.
- Knowledge in application of vision and image processing in robot operations.

**TEXT BOOKS:**

1. Carsten Steger, Markus Ulrich, Christian Wiedemann, “Machine Vision Algorithms and Applications”, WILEY-VCH, Weinheim, 2008.
2. Damian M Lyons, “Cluster Computing for Robotics and Computer Vision”, World Scientific, Singapore, 2011.

**REFERENCES:**

1. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, Addison - Wesley Publishing Company, New Delhi, 2007.
2. Shimon Ullman, “High-Level Vision: Object recognition and Visual Cognition”, A Bradford Book, USA, 2000.
3. R. Patrick Goebel, “ROS by Example: A Do-It-Yourself Guide to Robot Operating System – Volume I”, A Pi Robot Production, 2012.

**Subject: Machine Vision Lab**

**Code: RB-CS691**

**Contact Hours/week: 3L+1T**

**Credits: 2**

**Experiments:**

1. Train a semantic segmentation network using Deep Learning
2. Estimate 3D structure of a scene from 2D image
3. Combine multiple 3-point clouds to reconcile a 3D scene using iterative closest point (ICP) algorithm
4. Measure the diameter of Coins in world units using a single calibrated camera
5. Automatically determine the geometric transformation between a pair of images.
6. Perform automatic detection and motion-based tracking of moving objects in a video from a stationary camera.
7. Automatically create a panorama using feature-based image registration technique.

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**Subject:** Internet of things\*

**Code:** RBCS602

**Contact Hours/week:** 3L+1T

**Credits:** 4

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

UNIT1: Introduction: Sensing & actuation, Communication-Part I, Part II, Networking-Part I, Part II

UNIT 2: Industry 4.0: Globalization, The Fourth Revolution, LEAN Production Systems

UNIT 3: Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform

and Product Lifecycle Management

UNIT 4: Cybersecurity in Industry 4.0, Basics of Industrial IoT: Industrial Processes-Part I, Part II,

Industrial Sensing & Actuation

UNIT 5: IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business

Models-Part I, Part II, IIoT Reference Architecture-Part I, Part II.

UNIT 6: Industrial IoT- Layers: IIoT Sensing-Part I, Part II, IIoT Processing-Part I, Part II, IIoT

Communication-Part I.

UNIT 7: Industrial IoT- Layers: IIoT Communication , IIoT Networking-Part I, Part II, Part III.

UNIT 8: Industrial IoT: Big Data Analytics and Software Defined Networks: IIoT Analytics - Introduction, Machine Learning and Data Science

UNIT 9: Industrial IoT: Big Data Analytics and Software Defined Networks: SDN in IIoT- Part I, Part II,

Data Center Networks, Industrial IoT

UNIT 10: Industrial IoT: Security and Fog Computing - Fog Computing in IIoT, Security in IIoT-Part I,

Part II, Industrial IoT- Application Domains

UNIT 11: Industrial IoT- Application Domains: Healthcare, Power Plants

UNIT 12: Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies

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**Subject:** Internet of things Lab

**Code:** RBCS692

**Contact Hours/week:** 3L+1T

**Credits:** 2

List of Experiments:

1. Functional Testing Of Devices

Flashing the OS on to the device into a stable functional state by porting desktop environment with necessary packages.

2. Exporting Display On To Other Systems Making use of available laptop/desktop displays as a display for the device using SSH client & X11 display server.

3. GPIO Programming Programming of available GPIO pins of the corresponding device using native programming language. Interfacing of I/O devices like LED/Switch etc., and testing the functionality.

4. Interfacing Chronos eZ430 Chronos device is a programmable texas instruments watch which can be used for multiple purposes like PPT control, Mouse operations etc., Exploit the features of the device by interfacing with devices.

5. ON/OFF Control Based On Light Intensity Using the light sensors, monitor the surrounding light intensity & automatically turn ON/OFF the high intensity LED's by taking some pre-defined threshold light intensity value.

6. Battery Voltage Range Indicator Monitor the voltage level of the battery and indicating the same using multiple LED's (for ex: for 3V battery and 3 led's, turn on 3 led's for 2-3V, 2 led's for 1-2V, 1 led for 0.1-1V & turn off all for 0V)

7. Dice Game Simulation Instead of using the conventional dice, generate a random value similar to dice value and display the same using a 16X2 LCD. A possible extension could be to provide the user with option of selecting single or double dice game.

8. Displaying RSS News Feed On Display Interface Displaying the RSS news feed headlines on a LCD display connected to device. This can be adapted to other websites like twitter or other information websites. Python can be used to acquire data from the internet.

9. Porting Openwrt To the Device Attempt to use the device while connecting to a wifi network using a USB dongle and at the same time providing a wireless access point to the dongle.

10. Hosting a website on Board Building and hosting a simple website(static/dynamic) on the device and make it accessible online. There is a need to install server(eg: Apache) and thereby host the website.

11. Webcam Server Interfacing the regular usb webcam with the device and turn it into fully functional IP webcam & test the functionality.

12. FM Transmission Transforming the device into a regular fm transmitter capable of transmitting audio at desired frequency (generally 88-108 Mhz)

Note: Devices mentioned in the above lists include Arduino, Raspberry Pi, Beaglebone

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**Subject:** Project

**Code:** RBPR692

**Contact Hours/week:** 3L+1T

**Credits:** 6

Objectives: This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.