**Course Number** : AR502
**Course Name** : Advanced Design Practicum
**Credit Distribution** : 3-0-2-4
**Intended for** : PG and PhD
**Prerequisite** : Consent of faculty advisor
**Mutual Exclusion** **:** None

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**1. Preamble:**

The course gives an outline of the steps in solving an engineering design problem through an example of a robot building. The course is multidisciplinary of its kind and will be used to bring out the multidisciplinary aspects of a typical engineering design problem. The course unravels the different steps of engineering problem solving culminating in the development of a robot.

**2. Course Modules with quantitative lecture hours:**

**Introduction:** Engineering design - How to select an engineering problem, stages of solving a problem, documentation in Engineering, Machine and a robot - Different aspects of robotics, current problems in robotics. Drives and motion, pneumatic, hydraulic systems, clutch and brake. **(3 hours)**

**Practical 1:** Microelectronics, onboard computer, IoT, embedded electronic and materials to be used in the lab Manufacturing techniques - additive and subtractive manufacturing. **(3 hours)**

**Design of Mechanical Systems:** Introduction to CAD by 3D modeling software, Drawing of parts and assemblies, Computer-Aided Manufacturing and prototyping, Brief Introduction to robotic systems, Joints and transformations on ROS. **(5 hours)**

**Practical 2:** Introduction to Mechanical assembly, bill of materials, 3D modeling software and design of parts and assemblies and Static Stress Simulation. **(3 hours)**

**Practical 3:** Simulation in ROS environment (**3 hours)**

**Integration of Intelligent Control:** Sensor and Actuator selection and sizing, Determination of Power Source, Design of Power distribution, microcontroller, and motor driver circuits, Developing PCB boards and feasibility testing, Introduction to standard electronic connectors and American Wire Gauge. **(7 hours)**

**Practical 4: Sizing of sensors motors and linear actuators and integration into mechanical design. (3 hours)**

**Practical 5: Circuit Design using CAD tool and making PCBs manually and demonstration of CNC based PCB printing. (3 hours)**

**Programming and Signals:** Introduction to Programming; procedural vs object-oriented programming, Object-Oriented programming in practice, Signals; communication via PWM, UART, Design of hardware and software interrupts. **(6 hours)**

**Practical 6:** Introduction to Programming; procedural vs object-oriented programming. **(3 hours)**

**Practical 7:** Signals; communication via PWM, UART; connecting two microcontrollers. **(3 hours)**

**Practical 8:** Design of hardware and software interrupts. **(3 hours)**

**Integration of Compute and networks:** Introduction to microcontroller coding and interfacing with the ros API, Introduction to ROS packages and their deployment, Introduction

to IoT and IP sending receiving packets on client-server networks, Control of robotic platforms over IP, Deployment of real-time decision pipelines on the robot. **(6 hours)**

**Practical 9:** Intro to rosserial and connecting microcontrollers to ROS. **(3 hours)**

**Practical 10:** Introduction to esp8266; control via blynk. **(3 hours)**

**Practical 11:** Deployment of conditional path planning on robot and testing. **(3 hours)**

**Final project:** Project towards design and development of functional Robotic system.

**3. Textbooks:**

1. Robot Builder's Cookbook - Owen Bishop
2. Autodesk Fusion 360- Gaurav Verma
3. Introduction to SOLIDWORKS: A Comprehensive Guide with Applications in 3D Printing - Godfrey C. Onwubolu

**4. References:**

1. Programming Robots with ROS - Morgan Quigley, Brian Gerkey

**5. Similarity with the existing courses:**

**(Similarity content is declared as per the number of lecture hours on similar topics)**

| S. No. | | Course Code | Similarity Content | Approx. % of Content |
|---|---|---|---|---|
| 1. | | None | None | None |

**6. Justification of new course proposal if cumulative similarity content is >30%: None**