B. Sc. Physical Sciences with Electronics as one of the Core Disciplines

SKILL BASED COURSE – SBC 8-1: INTERFACING WITH ARDUINO

Course Title and Code	Credits	Credit distribution of the course			Pre-requisite of the course
		Lecture	Tutorial	Practical	
Interfacing with Arduino SBC 8-1	2	0	0	2	SBC 7-1: Arduino Programming

COURSE OBJECTIVES

- Explain the architecture and features of the Arduino Platform.
- Set up and use the Arduino IDE to write, debug, and upload code to an Arduino board.
- Write basic programs involving digital and analog I/O, loops, functions, and conditional statements.
- Implement simple tasks such as blinking LEDs, reading buttons, generating PWM signals, and reading analog voltages.
- Understand serial communication and use the Serial Monitor for debugging.
- Design small-scale automation and control programs using Arduino logic.

LEARNING OUTCOMES

- Identify and describe the working principles of common sensors (e.g., temperature, light, distance) and actuators (e.g., motors, buzzers).
- Interface sensors (LDR, DHT11, ultrasonic, IR, etc.) with Arduino and acquire data.
- Control actuators (relays, DC motors, stepper motors, servos, buzzers) using digital output and PWM.
- Design simple projects such as automatic lighting systems, object detection alarms, or temperature monitors.
- Implement basic feedback and control systems (e.g., temperature-based fan control).
- Troubleshoot common hardware and communication issues in Arduino circuits.

SYLLABUS OF SBC 8-1
(Hours: 60)

Apart from common experiments for all students on the listed topics, project-based learning (group activities) to be encouraged.

Unit I **(24 Hours)**

Interfacing with Sensors and Actuators

- Working with Sensors: Introduction to sensors (temperature, humidity, light, magnetic field etc.). Reading analog values.
- Analog and Digital Inputs/Outputs: Analog vs. Digital signals. Working with potentiometers, photoresistors, and thermistors.
- Interfacing with Motors: Controlling DC motors. Introduction to servos and stepper motors.
- Using Displays and Keypads: Interfacing with 7-segment displays and LCDs. Using keypads for input.
- Sound and Audio Output: Working with buzzers and speakers. Generating sound with Arduino.

Unit II **(36 Hours)**

Communication Protocols and Advanced Topics.

- Serial Communication: Understanding UART and Serial Communication. Communication between Arduino and computer.
- I2C and SPI Communication: Introduction to I2C and SPI protocols. Interfacing with external modules (e.g., sensors, displays).
- Wireless Communication: Introduction to wireless modules (Bluetooth, Wi-Fi). Simple projects using wireless communication.
- Data Logging: Reading and storing data from sensors. SD card modules and data logging projects.
- Introduction to IoT with Arduino: Basics of the Internet of Things (IoT). Simple IoT project: Sending data to a web server.
- Planning and designing your project.

SUGGESTED READINGS

"Getting Started With Arduino" By Massimo Banzi and Michael Shiloh. Shroff/Maker Media; fourth edition (2022). ISBN-13 : 978-9391043858

B. Sc. Physical Sciences with Electronics as one of the Core Disciplines

SKILL BASED COURSE – SBC 8-2: WEATHER FORECASTING

Course Title and Code	Credits	Credit distribution of the course			Pre-requisite of the course
		Lecture	Tutorial	Practical	
Weather forecasting SBC 8-2	2	1	0	1	

COURSE OBJECTIVES

The aim of this course is not just to impart theoretical knowledge to the students but to enable them to develop an awareness and understanding regarding the causes and effects of different weather phenomenon and basic forecasting techniques.

LEARNING OUTCOMES

The student will gain the following:

- Acquire basic knowledge of the elements of the atmosphere, its composition at various heights, variation of pressure and temperature with height.
- Learn basic techniques to measure temperature and its relation with cyclones and anti-cyclones.
- Knowledge of simple techniques to measure wind speed and its directions, humidity and rainfall.
- Understanding of absorption, emission and scattering of radiations in atmosphere; Radiation laws.
- Knowledge of global wind systems, jet streams, local thunderstorms, tropical cyclones, tornadoes and hurricanes.
- Knowledge of climate and its classification. Understanding various causes of climate change like global warming, air pollution, aerosols, ozone depletion, acid rain.
- Develop skills needed for weather forecasting, mathematical simulations, weather forecasting methods, types of weather forecasting, role of satellite observations in weather forecasting, weather maps etc. Uncertainties in predicting weather based on statistical analysis.
- Develop ability to do weather forecasts using input data.
- In the laboratory course, students should be able to learn: Principle of the working of a weather Station, Study of Synoptic charts and weather reports, Processing and analysis of weather data, Reading of Pressure charts, Surface charts, Wind charts and their analysis.

SYLLABUS OF SBC 8-2
THEORY COMPONENT
(Hours: 15)

Unit -1 **(8 Periods)**

Introduction to atmosphere: Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; temperature sensors: types; atmospheric pressure: its measurement
Measuring the weather: Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.

Unit-2 **(7 Periods)**

Weather systems: Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes.
Climate and Climate Change: Climate: its classification; causes of climate change; global warming and its outcomes; air pollution and its measurement, particulate matters PM 2.5, PM 10. Health hazards due to high concentration of PM2.5; aerosols, ozone depletion.
Basics of weather forecasting: Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts.

PRACTICAL COMPONENT: WEATHER FORECASTING
(Hours: 30)

Demonstrations and Experiments:
1. Study of synoptic charts & weather reports, working principle of weather station.
2. Processing and analysis of weather data:
   (a) To calculate the sunniest time of the year.
   (b) To study the variation of rainfall amount and intensity in different seasons.
   (c) To examine the maximum and minimum temperature throughout the year.
   (d) To study the relative humidity of the day and seasons and the entire year.
   (e) Development and movement of low and high Pressure system over Indian/global region.
3. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts, upper wind charts and its analysis.
4. Formats and elements in different types of weather forecasts/ warning (both aviation and non-aviation).
5. Simulation of weather system

6. Field visits to India Meteorological department and National center for medium range weather forecasting

REFERENCES

Essential Readings

1. Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books
2. The weather Observers Hand book, Stephen Burt, 2012, Cambridge University Press.
3. Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.
4. Text Book of Agro meteorology, S.R. Ghadekar, 2005,Agromet Publishers, Nagpur.
5. Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.

Additional Reading:

1. PM2.5 diminution and haze events over Delhi during the COVID-19 lockdown period: an interplay between the baseline pollution and meteorology, Nature- Scientific Reports, 10(13442). https://doi.org/10.1038/s41598- 020-70179-8., S. K. Dhaka, Chetna, V. Kumar, V. Panwar, A. P. Dimri, N. Singh, P. K. Patra, Y. Matsumi, M. Takigawa, and T. Nakayama (2020)
2. Chapter 1 - Composition and thermal structure of the earth's atmosphere, Atmospheric Remote Sensing, Principles and Applications, Earth Observation, 2023, Pages 1-18, https://doi.org/10.1016/B978-0-323-99262-6.00023-7. SK Dhaka and Vinay Kumar.
3. Climatic trends in temperature, relative humidity, and wind speed over Indian landmass and isle in Andaman Nicobar and Lakshadweep during 1981-2021, MAPAN-Journal of Metrology Society of India, (2024), DOI: 10.1007/s12647-024-00743-4, Shristy Malik, A.S. Rao, S K. Dhaka.
4. Decoding temporal patterns and trends of PM10 pollution over Delhi: A multi-year analysis (2015–2022). Environmental Monitoring and Assessment, 196(6), 500. https://doi.org/10.1007/s10661-024-12638-7, Chetna, Dhaka, S. K., Walker, S.-E., Rawat, V., & Singh, N. (2024).