



# ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ವಿಶ್ವವಿದ್ಯಾಲಯ

"ವಿಜಯ ಅಧಿನಿಯಮ ೧೯೯೪"ರ ಅಡಿಯಲ್ಲಿ, ಕರ್ನಾಟಕ ಸರ್ಕಾರದಿಂದ ಸ್ಥಾಪಿತವಾದ ರಾಜ್ಯ ವಿಶ್ವವಿದ್ಯಾಲಯ  
"ಜ್ಞಾನ ಸಂಗಮ", ಬೆಳಗಾವಿ-೫೯೦೦೧೮, ಕರ್ನಾಟಕ, ಭಾರತ

## Visvesvaraya Technological University

(State University of Government of Karnataka Established as per the VTU Act, 1994)

"Jnana Sangama" Belagavi-590018, Karnataka, India

Phone: (0831) 2498100, Fax: (0831) 2405467, Website: vtu.ac.in

**Dr. A. S. Deshpande** B.E., M.Tech., Ph.D.  
Registrar

Phone: (0831) 2498100  
Fax: (0831) 2405467

Ref: VTU/BGM/BOS/A9/2020-21 / 6677

Date: 16 MAR 2021

### CIRCULAR

Subject: Open Elective subjects added regarding.

Reference:

1. Chairperson BOS in Automobile Engineering dated 04.03.2021
2. Hon'ble Vice-Chancellor's approval dated 10.03.2021

Concerning the subject cited above, the following two OPEN ELECTIVE subjects are added to the scheme and syllabus of B.E. in Automobile Engineering (2018 Scheme)-

1. 18AU654 Renewable Energy Sources (Group A)
2. 18AU754 Introduction to Electrical Vehicles (Group B)

A syllabus copy is enclosed with this circular for reference to the concerned and also made uploaded on the VTU web portal @ <https://vtu.ac.in/en/b-e-scheme-syllabus/#menu0>

All the Principals of Engineering Colleges are hereby requested to make a note of the same and update this information to the concerned.

Encl: As mentioned above

Sd/-  
REGISTRAR

To,

- All the Principals of the Engineering Colleges under the ambit of VTU Belagavi.

Copy to:

1. The Registrar(Evaluation) for information and needful
2. The Registrar's Office, VTU, Belagavi, for information.
3. The Special Officer, Academic Section, VTU Belagavi, for information.
4. The Special Officer CNC section to upload the circular on the VTU web portal.

REGISTRAR

| B.E AUTOMOBILE ENGINEERING (AU)                                                                                                                                                                                                                                                                                                                                                  |                                                 |            |                    |                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|------------|--------------------|------------------------------|
| Outcome Based Education (OBE) and Choice Based Credit System (CBCS)                                                                                                                                                                                                                                                                                                              |                                                 |            |                    |                              |
| SEMESTER - VI                                                                                                                                                                                                                                                                                                                                                                    |                                                 |            |                    |                              |
| OPEN ELECTIVE - A                                                                                                                                                                                                                                                                                                                                                                |                                                 |            |                    |                              |
| Course Code                                                                                                                                                                                                                                                                                                                                                                      | 18AU65X                                         | CIE Marks  | 40                 |                              |
| Teaching Hours/Week (L:T:P)                                                                                                                                                                                                                                                                                                                                                      | (3:0:0)                                         | SEE Marks  | 60                 |                              |
| Credits                                                                                                                                                                                                                                                                                                                                                                          | 03                                              | Exam Hours | 03                 |                              |
| Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (For syllabus, please refer to the concerned Programme syllabus book or VTU website vtu.ac.in may be visited.).                                                                                                                            |                                                 |            |                    |                              |
| Selection of an open elective shall not be allowed if,                                                                                                                                                                                                                                                                                                                           |                                                 |            |                    |                              |
| <ul style="list-style-type: none"> <li>The candidate has studied the same course during the previous semesters of the programme.</li> <li>The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.</li> <li>A similar course, under any category, is prescribed in the higher semesters of the programme.</li> </ul> |                                                 |            |                    |                              |
| Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.                                                                                                                                                                                                                                                                       |                                                 |            |                    |                              |
| SINO                                                                                                                                                                                                                                                                                                                                                                             | Board and the Department offering the Electives | Course     |                    | Course Title                 |
|                                                                                                                                                                                                                                                                                                                                                                                  |                                                 | Sl No      | code under 18AU65X |                              |
|                                                                                                                                                                                                                                                                                                                                                                                  | Automobile Engineering                          | 1          | 18AU651            | Automobile Engineering       |
|                                                                                                                                                                                                                                                                                                                                                                                  |                                                 | 2          | 18AU652            | Vehicle Transport Management |
|                                                                                                                                                                                                                                                                                                                                                                                  |                                                 | 3          | 18AU653            | Non-Traditional Machining    |
|                                                                                                                                                                                                                                                                                                                                                                                  |                                                 | 4          | 18AU654            | Renewable Energy Sources     |

| B.E Please type the title of the programme (AUX) (Use Upper case)                                                                                                                                                                                                                                                                                                                |                                                 |            |                    |                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|------------|--------------------|-------------------------------------------|
| Outcome Based Education (OBE) and Choice Based Credit System (CBCS)                                                                                                                                                                                                                                                                                                              |                                                 |            |                    |                                           |
| SEMESTER - VII                                                                                                                                                                                                                                                                                                                                                                   |                                                 |            |                    |                                           |
| OPEN ELECTIVE - B                                                                                                                                                                                                                                                                                                                                                                |                                                 |            |                    |                                           |
| Course Code                                                                                                                                                                                                                                                                                                                                                                      | 18AU75X                                         | CIE Marks  | 40                 |                                           |
| Teaching Hours/Week (L:T:P)                                                                                                                                                                                                                                                                                                                                                      | (3:0:0)                                         | SEE Marks  | 60                 |                                           |
| Credits                                                                                                                                                                                                                                                                                                                                                                          | 03                                              | Exam Hours | 03                 |                                           |
| Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (For syllabus, please refer to the concerned Programme syllabus book or VTU website vtu.ac.in may be visited.).                                                                                                                            |                                                 |            |                    |                                           |
| Selection of an open elective shall not be allowed if,                                                                                                                                                                                                                                                                                                                           |                                                 |            |                    |                                           |
| <ul style="list-style-type: none"> <li>The candidate has studied the same course during the previous semesters of the programme.</li> <li>The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.</li> <li>A similar course, under any category, is prescribed in the higher semesters of the programme.</li> </ul> |                                                 |            |                    |                                           |
| Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.                                                                                                                                                                                                                                                                       |                                                 |            |                    |                                           |
| SINO                                                                                                                                                                                                                                                                                                                                                                             | Board and the Department offering the Electives | Course     |                    | Course Title                              |
|                                                                                                                                                                                                                                                                                                                                                                                  |                                                 | Sl No      | code under 18AU75X |                                           |
|                                                                                                                                                                                                                                                                                                                                                                                  | Automobile Engineering                          | 1          | 18AU751            | Engineering Economics and Cost Estimation |
|                                                                                                                                                                                                                                                                                                                                                                                  |                                                 | 2          | 18AU752            | Total Quality Management                  |
|                                                                                                                                                                                                                                                                                                                                                                                  |                                                 | 3          | 18AU753            | Non-destructive Testing                   |
|                                                                                                                                                                                                                                                                                                                                                                                  |                                                 | 4          | 18AU754            | Introduction to Electrical Vehicle        |



| <b>B. E. AUTOMOBILE ENGINEERING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |            |    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|------------|----|
| Outcome Based Education (OBE) and Choice Based Credit System (CBCS)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |            |    |
| <b>SEMESTER - VI</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         |            |    |
| <b>OPEN ELECTIVE - A</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |            |    |
| <b>RENEWABLE ENERGY SOURCES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |            |    |
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 18AU654 | CIE Marks  | 40 |
| TeachingHours/Week (L:T:P)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | (3:0:0) | SEE Marks  | 60 |
| Credits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 03      | Exam Hours | 03 |
| <b>Course Learning Objectives: To</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |         |            |    |
| <ul style="list-style-type: none"> <li>• To understand role and significance of solar energy.</li> <li>• To discuss the importance of Wind Energy.</li> <li>• To be aware of the role geothermal energy in the Energy Generation.</li> <li>• To know the significance of ocean energy</li> <li>• To realize utilization of hydrogen energy and hydroelectric energy</li> </ul>                                                                                                                                                                                                   |         |            |    |
| <b>Module-1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |            |    |
| <b>SOLAR ENERGY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |            |    |
| Introduction, Solar constant, Solar radiation measurements, Solar thermal conversion: Basics, Flat plate collectors-liquid and air type. Theory of flat plate collectors, Concentrators: optical design of concentrators, Solar radiation geometry, solar radiation data, Estimation of average solar radiation Applications of solar energy: solar water heater, solar dryers, Solar ponds, solar cooling, Solar thermal power generation. Solar photovoltaic: Principle of photovoltaic conversion of solar energy. Solar cells, Solar PV pumps, Solar energy storage options. |         |            |    |
| <b>Module-2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |            |    |
| <b>WIND ENERGY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |         |            |    |
| Introduction, Basic principles of wind energy conversion, the nature of wind, power in the wind, wind energy conversion, wind data and energy estimation, site selection considerations, basic components of WECS, classification of WEC systems, wind energy collectors, horizontal axis machines, vertical axis machines, relative advantages and disadvantages, performances of wind machines, generating systems, Energy storage, applications of wind energy.                                                                                                               |         |            |    |
| <b>Module-3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |            |    |
| <b>GEO THERMAL ENERGY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |         |            |    |
| Introduction, estimates of Geothermal power, nature of Geothermal fields, Geothermal sources, hydrothermal resources, vapour dominated power plant, liquid dominated systems, characteristics of geo thermal steam electric plants, Geopressured resources, heat extraction from hot dry rocks, Magma resources<br>Prime movers for geothermal energy conversion, advantages and disadvantages of geothermal energy, applications of Geothermal energy, Geothermal exploration, operational and environmental problems                                                           |         |            |    |
| <b>Module-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |            |    |
| <b>OCEAN ENERGY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |            |    |
| Introduction, Methods of ocean thermal electric power generation, open OTEC system, closed OTEC system, site selection. Principle of Tidal power generation, components of Tidal power plants, operation methods of utilization of Tidal energy site requirements, storage, advantages and limitations of Tidal power.<br>Wave energy-introduction, advantages and disadvantages of wave energy, energy and power                                                                                                                                                                |         |            |    |

from the waves, wave energy conversion devices.

#### Module-5

#### HYDROGEN AND HYDROELECTRIC ENERGY

Hydrogen Energy - introduction and application, General introduction to infrastructure requirement for hydrogen production, storage, dispensing & utilization. Electrochemical: Electrolysis, Photo electro chemical, Hydrogen storage methods, Hydrogen transportation, hydrogen utilization

Small scale hydroelectric stations, classification, components, Design considerations for mini and micro hydel projects, bulb and tube turbine for small scale hydro electric, advantages and limitations of small scale hydro electric.

#### Course Outcomes:

At the end of the course the student will be able to:

- Understand the role and significance of solar energy.
- Explain the importance of Wind Energy.
- Discuss the role of geothermal energy in the Energy Generation.
- Describe the ocean energy and its importance
- Illustrate the Utilization of hydrogen energy and hydroelectric energy

#### Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

| Sl. No.                | Title of the Book                           | Name of the Author/s      | Name of the Publisher         | Edition and Year |
|------------------------|---------------------------------------------|---------------------------|-------------------------------|------------------|
| <b>Textbook/s</b>      |                                             |                           |                               |                  |
| 1                      | Fundamental of Renewable Energy Sources     | Tiwari GN. Ghoshal MK.    | Narosa                        | 2007             |
| 2                      | Power Plant Engineering                     | Nag P K                   | Tata McGraw Hill              | 2008             |
| 3                      | Solar Energy                                | Sukatme,                  | Tata McGraw Hill              |                  |
| 4                      | Non Conventional Energy Sources             | G.D.Rai                   | Khanna Publishers, New Delhi  | 2011             |
| <b>Reference Books</b> |                                             |                           |                               |                  |
| 1                      | Chemical and Electrochemical Energy Systems | Narayan R. Biswanathan B  | University Press (India) Ltd. | 1998.            |
| 2                      | Present and Future Automotive Fuels         | Osamu Hairo and Richard K | John Wiley and Sons           | 1988             |
| 3                      | Renewable Energy Resources                  | J W Twidell & A D Weir    | ELBS,                         | 2006             |

| <b>B. E. AUTOMOBILE ENGINEERING</b>                                                                                                                                                                                                                                                                                        |         |            |    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|------------|----|
| Outcome Based Education (OBE) and Choice Based Credit System (CBCS)                                                                                                                                                                                                                                                        |         |            |    |
| SEMESTER - VII                                                                                                                                                                                                                                                                                                             |         |            |    |
| <b>OPEN ELECTIVE - B</b>                                                                                                                                                                                                                                                                                                   |         |            |    |
| <b>INTRODUCTION TO ELECTRIC VEHICLES</b>                                                                                                                                                                                                                                                                                   |         |            |    |
| Course Code                                                                                                                                                                                                                                                                                                                | 18AU754 | CIE Marks  | 40 |
| TeachingHours/Week (L:T:P)                                                                                                                                                                                                                                                                                                 | (3:0:0) | SEE Marks  | 60 |
| Credits                                                                                                                                                                                                                                                                                                                    | 03      | Exam Hours | 03 |
| <b>Course Learning Objectives: To</b>                                                                                                                                                                                                                                                                                      |         |            |    |
| <ul style="list-style-type: none"> <li>• Explain the need, past, present &amp; future of EVs, recent development</li> <li>• Describe basic terms of electrical and EV parameters</li> <li>• Explain major components of battery operated EVs</li> <li>• Describe the energy storage technologies and fuel cells</li> </ul> |         |            |    |
| <b>Module-1</b>                                                                                                                                                                                                                                                                                                            |         |            |    |
| <b>Engineering philosophy of EV development</b>                                                                                                                                                                                                                                                                            |         |            |    |
| Introduction, need of electric drive, Past, present and future of EVs, Past 30 years development, Present major issues, Historical development, Recent development, Development trends, Engineering philosophy of EVs, EV concept, Key EV technologies                                                                     |         |            |    |
| <b>Module-2</b>                                                                                                                                                                                                                                                                                                            |         |            |    |
| <b>Basic terms of Electrical and EV parameters</b>                                                                                                                                                                                                                                                                         |         |            |    |
| Electrical terms – current, AC & DC, voltage, power, conductors, insulators, resisters, relays, capacitors, solenoids, AC & DC motors & generators. EV parameters, Weight and size parameters, Force parameters, Energy parameters, Performance parameters.                                                                |         |            |    |
| <b>Module-3</b>                                                                                                                                                                                                                                                                                                            |         |            |    |
| <b>The Basics of a Battery-Operated Electric Vehicle (BOEV)</b>                                                                                                                                                                                                                                                            |         |            |    |
| Advantages and disadvantages, major components of BOEV, comparison with IC engine vehicles, flywheel energy storage, major parts, controller, inverter/converter, Regenerative Braking, Driving an EV – Starting, Driving and Braking. Basic Diagnosis &Precautions, Self-Diagnostics.                                     |         |            |    |
| <b>Module-4</b>                                                                                                                                                                                                                                                                                                            |         |            |    |
| <b>Energy Storage Technology:</b>                                                                                                                                                                                                                                                                                          |         |            |    |
| Battery basics, different types of batteries (lead-acid battery, Lithium / Alkaline, Lithium ion, Nickel metal hydride), High discharge capacitors, battery ratings, battery parameters, Battery discharging & charging characteristics, Battery chargers, Battery indicating methods and devices                          |         |            |    |
| <b>Module-5</b>                                                                                                                                                                                                                                                                                                            |         |            |    |
| <b>Fuel Cells</b>                                                                                                                                                                                                                                                                                                          |         |            |    |
| Fuel cell characteristics, fuel cell types - alkaline fuel cell, proton exchange membrane, direct methanol fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, hydrogen storage systems, reformers, fuel cell EV.                                                                     |         |            |    |
| <b>Course Outcomes:</b>                                                                                                                                                                                                                                                                                                    |         |            |    |
| At the end of the course the student will be able to:                                                                                                                                                                                                                                                                      |         |            |    |
| <ul style="list-style-type: none"> <li>• Explain need, past, present &amp; future of EVs, recent development</li> <li>• Describe basic terms of electrical and EV parameters</li> <li>• Explain major components of battery operated EVs</li> <li>• Describe the energy storage technologies and fuel cells</li> </ul>     |         |            |    |

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

| <b>Sl. No.</b>         | <b>Title of the Book</b>                         | <b>Name of the Author/s</b>     | <b>Name of the Publisher</b>                                              | <b>Edition and Year</b> |
|------------------------|--------------------------------------------------|---------------------------------|---------------------------------------------------------------------------|-------------------------|
| <b>Textbook/s</b>      |                                                  |                                 |                                                                           |                         |
| 1                      | Modern Electric Vehicle                          | Technology C.C Chan & K.T Chau, | Oxford University Press,                                                  | 2001                    |
| 2                      | Hybrid Electric & Fuel Cell Vehicles             | Jack Erjavec,                   | Delmar, Cengage Learning,                                                 | 2013                    |
| <b>Reference Books</b> |                                                  |                                 |                                                                           |                         |
| 3                      | Electric And Hybrid Vehicles Design Fundamentals | Iqbal Husain                    | CRC Press                                                                 | 2005                    |
| 4                      | The Electric Car                                 | Michael H. Westbrook            | British Library Cataloguing in Publication IET Power and Energy Series 38 |                         |
| 5                      | Electric and Hybrid Vehicles                     | Tom Denton                      | Routledge                                                                 | 2016                    |