Subject Description Form

<table>
<tr><td>Subject Code</td><td>EE547</td></tr>
<tr><td>Subject Title</td><td>Electric Vehicle Charging Systems</td></tr>
<tr><td>Credit Value</td><td>3</td></tr>
<tr><td>Level</td><td>5</td></tr>
<tr><td>Pre-requisite/ Co-requisite/ Exclusion</td><td>Nil</td></tr>
<tr><td>Objectives</td><td>1. To acquire a broad knowledge of electric vehicle charging technology
2. To understand the development of electric vehicle charger from technological, environmental, and societal perspectives.</td></tr>
<tr><td>Intended Learning Outcomes</td><td>Upon completion of the subject, students will be able to:
a Understand the importance of chargers as it pertains to environmental concerns, energy sustainability, climate change, and global policy.
b. Understand various underpinning technologies for charger including conductive, wireless and battery swapping.
c. Acquire the knowledge of charger practice, charger policy and infrastructure.</td></tr>
<tr><td>Subject Synopsis/ Indicative Syllabus</td><td>1. Introduction to electric vehicle charging technology: Charging system, Constant voltage, Constant current, Pulse charging.
2. Charger Circuit: Circuit topology, Charging control, AC and DC chargers, Semi-fast, fast and quick chargers.
3. Inductive charging: Concept of wireless power transfer, Dynamic wireless charger, Coil design, Coupling, Electromagnetic interference.
4. Charger standards: Wireless standards including Qi, PMA, A4WP, Magnet, conductive charger standard including CHAdeMO, SAE and IEC, Connection and plug.
5. Charger infrastructure: Charging station and network, pantograph, load management, Vehicle to Grid, EV Penetration, Synergistic control of EV and planning.
6. Other Charging technologies: Battery swapping, Hydrogen and solid fuel.</td></tr>
<tr><td>Teaching/Learning Methodology</td><td>Delivery of the subject is mainly through formal lectures, complemented by tutorials. worked examples and assignment. Self-learning on the part of students is strongly encouraged and extensive use of web resources will be made.
<table>
<tr><td rowspan="2">Teaching/Learning Methodology</td><td colspan="3">Intended subject learning outcomes</td></tr>
<tr><td>a</td><td>b</td><td>c</td></tr>
<tr><td>1. Lectures</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>2. Tutorials</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>3. Assignment</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>4. Laboratory</td><td></td><td>✓</td><td></td></tr>
</table>
</td></tr>
</table>

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed		
		a	b	c
1. Assignment	20%	✓	✓	✓
2. Laboratory performance & reports	10%		✓	
3. Test	20%	✓	✓	✓
4. Examination	50%	✓	✓	✓
Total	100 %			

The assignment is designed to assess students' understanding of the electric vehicle charging principles and whether they can present the study clearly. It may include the take-home assignment and/or mini-project.

Laboratory class is designed to teach students some practical understanding of a charger and its operation.

The test is designed to assess students' understanding of the topics that they have learnt relative to learning outcomes (a), (b) and (c). The test is usually conduced in the mid-semester to measure students' performance.

Examination: questions are designed to assess learning outcomes (a), (b) and (c). Students are required to answer questions that cover all of the learning outcomes.

Student Study Effort Expected

Class contact:	
▪ Lecture	27 Hrs.
▪ Laboratory, Tutorial and Presentation	12 Hrs.
Other student study effort:	
▪ Mini project or Assignment	21 Hrs.
▪ Laboratory	6 Hrs.
▪ Self study	49 Hrs.
Total student study effort	115 Hrs.

Reading List and References

1. K.T.Chau, "Battery Systems Electric Vehicle Machines and Drives", Wiley 2015.
2. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer New York, 2013
3. Rik De Doncker, Duco W.J. Pulle, André Veltman, "Advanced Electrical Drives - Analysis, Modeling, Control", Springer Dordrecht Heidelberg London New York, 2011.
4. The Institution of Engineering and Technology, "Code of Practice for Electric Vehicle Charging Equipment Installation", IET Standard, 3rd edition, 2018.
5. C.T.Rim, C.Mi, "Wireless Power Transfer for Electric Vehicles and Mobile Devices", Wiley – IEEE, 1st Edition, Kindle Edition, 2017.
6. L.A.Kumar, S.A.Alexander, "Power Converters for Electric Vehicles", 1st Edition, Kindle Edition, 2020.
7. Mohammad Saad Alam, Reji Kumar Pillai, N. Murugesan, Developing Charging Infrastructure and Technologies for Electric Vehicles (Advances in Mechatronics and Mechanical Engineering), Engineering Science Reference, 2021
8. Per Enge, Nick Enge, Stephen Zoepf, Electric Vehicle Engineering", McGraw Hill, 2021.