SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE
(AUTONOMOUS)

(Approved by AICTE, New Delhi, Affiliated to JNTUK, Kakinada)

Accredited by NAAC with 'A+' Grade

Recognised as Scientific and Industrial Research Organisation

SRKR MARG, CHINA AMIRAM, BHIMAVARAM – 534204 W.G.Dt., A.P., INDIA

Regulation: R23	

ELECTRICAL AND ELECTRONICS ENGINEERING (Minors)

(Applicable for AIDS, AIML, CIC, CSBS,CSE, CSG, CSIT, ECE, CE, IT & ME)

COURSE STRUCTURE
(With effect from 2023-24 admitted Batch onwards)

Course Code	Course Name	Year/ Sem	Cr	L	T	P	C.I.E	S.E.E	Total Marks
B23EEM101	Power Transmission & Distribution	II-II	3	3	0	0	30	70	100
B23EEM201	Electrical Machines & Applications	III-I	3	3	0	0	30	70	100
B23EEM301	Power Conversion & Battery Storage	III-II	3	3	0	0	30	70	100
B23EEM401	Electric Vehicle Fundamentals	IV-I	3	3	0	0	30	70	100
B23EEM501	*MOOCS-I	II-II to IV-I	3	--	--	--	--	--	100
B23EEM601	*MOOCS-II	II-II to IV-I	3	--	--	--	--	--	100
		TOTAL	**18**	**12**	**0**	**0**	**120**	**280**	**600**

*Two MOOCS courses of any **ELECTRICAL AND ELECTRONICS ENGINEERING** related Program Core Courses from NPTEL/SWAYAM with a minimum duration of 12 weeks (3 Credits) courses other than the courses offered need to be takenby prior information to the concern. These courses should be completed between II Year II Semester to IV Year I Semester.

Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23EEM101	**Minor**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

POWER TRANSMISSION AND DISTRIBUTION

(Minor Degree course in EEE)

Course Objectives: Students will learn about

1.	The power supply systems and conductor material requirements for Overhead system.
2.	The mechanical design of transmission lines and insulator requirements.
3.	The performance analysis of different types of transmission lines.
4.	The different types of distribution systems
5.	The underground cables and different substations.

Course Outcomes: At the end of the course, the students will be able to

S. No	Outcomes	Knowledge Level
1.	Explore D.C and A.C transmission networks and calculate Conductor material requirement.	K3
2.	Examine the mechanical and electrical design aspects of transmission system.	K3
3.	Determine the performance of short and medium transmission lines	K3
4.	Illustrate the working of D.C and A.C Distribution systems	K3
5.	Explore the underground cables and illustrate different substations	K3

SYLLABUS

UNIT-I (10 Hrs)	**Electrical Supply Systems:** Introduction, Typical A.C & D.C Power Supply Schemes, Advantages of High Transmission Voltage, D.C 2 - wire and 3 - wire systems, A.C single phase, three phase 3 – wire and three phase 4 - wire systems, comparison of copper efficiency, Kelvin's Law, Comparison of D.C. and A.C. Transmission.
UNIT-II (10 Hrs)	**Mechanical Design of Overhead Lines:** Main components of Overhead Lines, Insulators - Types of Insulators, Potential Distribution over Suspension Insulator, String Efficiency, Methods of Improving String Efficiency, Corona effect, Skin effect, Ferranti effect.
UNIT-III (10 Hrs)	**Performance of Transmission Lines:** Constants of a Transmission Line, Classification of overhead Transmission Lines, Regulation and efficiency of a Transmission Line, Short Transmission Lines, Medium Transmission Lines - End Condenser Method, Nominal T Method & Nominal π Method.

UNIT-IV (10 Hrs)	**Distribution Systems:** Classification of Distribution Systems, Types of D.C. Distributors, D.C. Distribution Calculations, D.C. distributor fed at one end (concentrated loading), Distributor fed at both ends (concentrated loading). Introduction to AC Distribution system.
UNIT-V (10 Hrs)	**Underground Cables and Substations:** Underground cables, Construction & types of cables, comparison of overhead and underground transmission system, Substation - Functions of Substation, Classification of substations, Symbols for equipment in substation, Single bus bar arrangement in Substations.
Text Books:	
1.	Electrical power Systems by C.L.Wadhwa, New Age International, 8th Edition,2022.
2.	Principles of Power systems by V.K. Mehta S. Chand Publications, 3rd Edition, 2022.
Reference Books:	
1.	A Textbook on Power System Engineering. Gupta, M.L. Soni, U.S. Bhatnagar, A. Chakrabarti. 9th Edition,2009.
2.	Generation, Distribution, utilization of Electrical Energy by C.L.Wadhwa, New Academic Science,2011.
e-Resources:	
1.	https://nptel.ac.in/courses/108102047
2.	https://nptel.ac.in/courses/108105104

				Course Code: B23EEM101	
		SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE (A)			**R23**
		II B.Tech. II Semester MODEL QUESTION PAPER			
		POWER TRANSMISSION & DISTRIBUTION			
		(Minor Degree course in EEE)			
Time: 3 Hrs.				**Max. Marks: 70 M**	
		Answer Question No.1 compulsorily			
		Answer **ONE Question** from **EACH UNIT**			
		Assume suitable data if necessary			
				10 x 2 = 20 Marks	
			CO	**KL**	**M**
1.	**a).**	What is meant by a transmission system.	**1**	**2**	**2**
	b).	What are disadvantages of d.c. transmission system?	**1**	**2**	**2**
	c).	Define string efficiency.	**2**	**1**	**2**
	d).	What is meant by Ferranti effect?	**2**	**2**	**2**
	e).	Classify different types of transmission systems.	**3**	**1**	**2**
	f).	Define voltage regulation in Transmission lines.	**3**	**2**	**2**
	g).	Define distributor.	**4**	**2**	**2**
	h).	Write any two advantages of ring distribution system over radial distribution systems.	**4**	**1**	**2**
	i).	Describe the functions of substation.	**5**	**1**	**2**
	j).	List out different types of Earthing methods.	**5**	**2**	**2**
				5 x 10 = 50 Marks	
		UNIT-1			
2.	**a).**	Explain the advantages of high transmission voltage.	**1**	**3**	**5**
	b).	Compare the volume of conductor material required for a d.c. 2-wire system and 3-phase, 3-wire system on the basis of equal maximum potential difference between one conductor and earth. Make suitable assumptions.	**1**	**3**	**5**
		OR			
3.	**a).**	Compare D.C. and A.C. Transmission lines	**1**	**3**	**5**
	b).	State and prove Kelvin's law for size of conductor for transmission. Discuss its Limitations.	**1**	**3**	**5**
		UNIT-2			
4.	**a).**	Explain the methods to improve string efficiency.	**2**	**3**	**5**
	b).	In a 33 kV overhead line, there are three units in the string of insulators. If the capacitance between each insulator pin and earth is 11% of self-	**2**	**3**	**5**

		capacitance of each insulator, Calculate (i) the distribution of voltage over 3 insulators and (ii) string efficiency.			
		OR			
5.	**a).**	Explain the Corona phenomenon in transmission lines.	**2**	**3**	**5**
	b).	Discuss the various types of electrical insulators and their applications in electrical systems.	**2**	**3**	**5**
		UNIT-3			
6.	**a).**	Explain the short transmission lines with phasor diagram.	**3**	**3**	**5**
	b).	A 3-phase line delivers 3600 kW at a p.f. 0·8 lagging to a load. If the sending end voltage is 33 kV, **determine** (i) the receiving end voltage (ii) line current (iii) transmission efficiency. The resistance and reactance of each conductor are 5·31 Ω and 5·54 Ω respectively.	**3**	**3**	**5**
		OR			
7.		**Derive** the expressions for sending end voltage, current, power and p.f., transmission efficiency in a medium transmission line using nominal – T method and also draw the phasor diagram.	**3**	**3**	**10**
		UNIT-4			
8.	**a).**	Draw and **explain** schematic diagram of radial and ring main distribution system.	**4**	**3**	**5**
	b).	A 2-wire d.c. distributor cable AB is 2 km long and supplies loads of 100A, 150A, 200A and 50A situated 500 m, 1000 m, 1600 m and 2000 m from the feeding point A. Each conductor has a resistance of 0·01 Ω per 1000 m. **Calculate** the p.d. at each load point if a p.d. of 300 V is maintained at point A.	**4**	**3**	**5**
		OR			
9.	**a).**	Explain the types of D.C. Distributors with a neat sketches.	**4**	**3**	**5**
	b).	A d.c. distributor AB is fed at both ends. At feeding point A, the voltage is maintained at 235 V and at B at 236 V. The total length of the distributor is 200m and loads are tapped off as under : 20 A at 50 m from A 40 A at 75 m from A 25 A at 100 m from A 30 A at 150 m from A The resistance per kilometre of one conductor is 0.4 Ω. Calculate the minimum voltage and the point at which it occurs.	**4**	**3**	**5**
		UNIT-5			
10.	**a).**	Explain the construction of underground cable with a neat sketch.	**5**	**3**	**5**
	b).	Compare overhead and underground transmission system.	**5**	**3**	**5**

		OR			
11.	**a).**	Explain the Single bus bar arrangement in substations with a neat diagram	**5**	**3**	**5**
	b).	Explain pipe earthing with a neat sketch.	**5**	**3**	**5**

CO-COURSE OUTCOME **KL-KNOWLEDGE LEVEL** **M-MARKS**

NOTE : Questions can be given as A,B splits or as a single Question for 10 marks

Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23EEM201	**Minor**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

ELECTRICAL MACHINES & APPLICATIONS

(Minor Degree course in EEE)

Course Objectives: Students will learn about

1.	The principle and construction of DC generator, characteristics of DC generators.
2.	The working principle of operation, characteristics of DC Motor and testing of DC Machines.
3.	The construction, operating principle of single-phase transformer, losses and efficiency and polyphase connections.
4.	The construction, operation and performance of induction motors.
5.	The working and performance of synchronous machines.

Course Outcomes: At the end of the course, the students will be able to

S.No	Outcome	Knowledge Level
1.	Apply the concepts of electromechanical energy conversion to understand the principle and performance of DC generator.	K3
2.	Explore the performance of DC motors & testing of DC machines.	K3
3.	Obtain the parameters of equivalent circuit, efficiency & regulation of single-phase transformer and illustrate the polyphase connections.	K3
4.	Illustrate the construction, and operation of inductions machines and analyze the performance of three-phase induction motor.	K4
5.	Explore the construction & operation of Synchronous machines and analyze the performance.	K4

SYLLABUS

UNIT-I (10Hrs)	**DC Generators:** Construction and principle of operation of DC machines – EMF equation for generator – Methods of Excitation – characteristics of DC generators – Applications of DC Generators
UNIT-II (10 Hrs)	**DC Motors and Testing of DC Machines:** Principle operation of DC Motor, Back-emf and Torque equation of DC motor, Types of DC motors, Characteristics of DC motors – losses and efficiency – Applications of DC motors. Testing of DC machines – Brake test, Swinburne's test
UNIT-III (10 Hrs)	**Transformers:** Introduction to single-phase Transformers (Construction and principle of operation)–emf equation – operation on no-load and on load –lagging, leading and unity power factors loads- equivalent circuit –regulation – losses and efficiency-Open Circuit and Short Circuit tests – Three Phase Transformers - Y/Y, Y/Δ, Δ/Y, Δ/Δ connections, Applications of Transformers

UNIT-IV (10 Hrs)	**Induction Machines:** Three Phase Induction Motors: Construction of Squirrel cage and Slipring induction motors– production of rotating magnetic field – principle of operation – slip and slip frequency – rotor emf, rotor current and power factor at standstill and during running conditions–Power flow diagram, Rotor Output, Torque equation – torque-slip characteristics, Brake test. Single Phase Induction Motors: Construction and Working – Double field revolving Theory, Split Phase Motors – Resistance Start Induction Motor. Applications of Induction Motors.
UNIT-V (10 Hrs)	**Synchronous Machines:** Generators (Alternators): Constructional features of salient pole and non-salient pole synchronous generators, E.M.F equation. Synchronous Motors: Principle and theory of operation, Starting of synchronous Motors – Operating characteristics of synchronous motor - variable excitation and constant load, Applications of Synchronous Machines.

Textbooks:	
1.	Electrical Technology Volume 2 by Theraja B.L., Theraja A.K., S Chand Publications, 2021.
2.	Electrical Machines by R.K Rajput., Laxmi Publications, 4th edition, 2006.
Reference Books:	
1.	Electrical Machinery, Dr. P.S. Bhimbra, Khanna Publishing, 2021,1st Edition
2.	Theory & Performance of Electrical Machines by J.B.Gupta, S.K.Kataria & Sons, 15th edition, 2015.
e-Resources	
1.	https://nptel.ac.in/courses/117106108
2.	https://nptel.ac.in/courses/108105131

		Course Code: B23EEM201			
		SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE (A)			**R23**
		III B.Tech. I Semester MODEL QUESTION PAPER			
		ELECTRICAL MACHINES & APPLICATIONS			
		(Minor Degree course in EEE)			
Time: 3 Hrs.					**Max. Marks: 70 M**
		Answer Question No.1 compulsorily			
		Answer **ONE Question** from **EACH UNIT**			
		Assume suitable data if necessary			
					10 x 2 = 20 Marks
			CO	**KL**	**M**
1.	**a).**	State the basic parts of a DC Machine.	**1**	**3**	**2**
	b).	Write the e.m.f equation for D.C Generator.	**1**	**3**	**2**
	c).	What is back e.m.f in D.C Motors	**2**	**4**	**2**
	d).	Name any four applications of D.C series motors	**2**	**4**	**2**
	e).	State different losses which occur in a transformer	**3**	**3**	**2**
	f).	Define voltage regulation of a transformer.	**3**	**3**	**2**
	g).	What are sliprings.	**4**	**4**	**2**
	h).	Give the condition for maximum torque for 3-phase induction motor	**4**	**4**	**2**
	i).	Mention the basic parts of a synchronous motor.	**5**	**4**	**2**
	j).	Mention the need for starters in synchronous motors.	**5**	**4**	**2**
					5 x 10 = 50 Marks
		UNIT-1			
2.	**a).**	Explain the different methods of excitation in DC generators.	**1**	**3**	**5**
	b).	A long-shunt compound generator delivers a load current of 50 A at 500 V and has armature, series field and shunt field resistance of 0.05 Ω, 0.03 Ω and 250 Ω respectively. Calculate the generated voltage and the armature current.	**1**	**3**	**5**
		OR			
3.	**a).**	Explain the construction of de machine with neat diagram.	**1**	**3**	**5**
	b).	Derive an expression for the emf generated in the armature winding of a DC machine.	**1**	**3**	**5**
		UNIT-2			
4.	**a).**	Explain swinburne's test for finding efficiency of DC machines.	**2**	**3**	**5**
	b).	Derive the Torque equation of a DC motor.	**2**	**3**	**5**
		OR			

5.	**a).**	A 250V DC shunt motor has armature resistance of 0.25 ohm on load it takes an armature current of 50A and runs at 750rpm. If the flux of the motor is reduced by 10% without changing the load torque, find the new speed of the motor.	**2**	**3**	**5**
	b).	Explain different losses that occur in a D.C motor.	**2**	**3**	**5**
		UNIT-3			
6.	**a).**	What are the tests required to draw the equivalent circuit of a Single-phase Transformer? How they are conducted?	**3**	**3**	**5**
	b).	A 6600/440V Single phase 600 KVA transformer has 1200 primary turns. Find (i) Transformation ratio (ii) Secondary turns (iii) Voltage / turn (iv) Secondary current when it supplies a load of 400 kW at 0.8 p.f. lagging.	**3**	**3**	**5**
		OR			
7.	**a).**	Explain the construction and principle of operation of single-phase transformer	**3**	**3**	**5**
	b).	A 50 KVA, 4400/220 V, transformer has R1 = 3.45 Ω; R2 = 0.009Ω. The values of reactances are X1 = 5.2Ω and X2 = 0.015Ω. Calculate for the transformer. (i) Equivalent resistance referred to primary (ii) Equivalent reactance reference to primary (iii) Equivalent impedance reference to primary (iv) Equivalent resistance, reactance and impedance referred to secondary	**3**	**3**	**5**
		UNIT-4			
8.	**a).**	Describe the constructional features of squirrel cage and slip ring induction motors.	**4**	**4**	**5**
	b).	Discuss the different power stages of a 3-phase induction motor with losses with the help of a power flow diagram.	**4**	**4**	**5**
		OR			
9.	**a).**	Derive the expression for torque, slip and draw speed-torque characteristics of 3-phase induction motor.	**4**	**4**	**10**
		UNIT-5			
10.	**a).**	Explain the construction of a synchronous machine.	**5**	**4**	**5**
	b).	Explain the working of a synchronous condenser.	**5**	**4**	**5**
		OR			
11.	**a).**	Explain 'V' and inverted 'V' curves of a synchronous motor.	**5**	**4**	**5**
	b).	Derive the e.m.f equation of a synchronous generator.	**5**	**4**	**5**

CO-COURSE OUTCOME **KL-KNOWLEDGE LEVEL** **M-MARKS**

NOTE : Questions can be given as A,B splits or as a single Question for 10 marks

Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23EEM301	**Minor**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

POWER CONVERSION SYSTEMS AND BATTERY STORAGE

(Minor Degree course in EEE)

Course Objectives: Students will learn about

1.	The operation, characteristics and applications of SCR, MOSFET & IGBT in power electronics.
2.	The operation and performance of rectifiers and inverters used in power conversion systems.
3.	The principles and types of DC-DC & AC-AC converters for load requirement.
4.	The construction, working and types of standard, modern and flow batteries.
5.	The Battery charging, parameters & Battery Management System.

Course Outcomes: At the end of the course, the students will be able to

S.No	Outcome	Knowledge Level
1.	Explore SCR, MOSFET & IGBT characteristics, triggering methods and commutation techniques.	K3
2.	Analyze AC-DC and DC-AC converters including conduction modes and harmonic effects.	K4
3.	Explore the DC-DC converters, AC voltage controllers and cycloconverters.	K3
4.	Explore different types of batteries for energy storage.	K3
5.	Illustrate the parameters & functionalities of Battery Management System.	K3

SYLLABUS

UNIT-I (10Hrs)	**Power Semiconductor Devices:** Introduction, Advantages and application of power Electronic Converters, Power Semiconductor Devices: SCR, MOSFET & IGBT, Static characteristics of SCR, MOSFET & IGBT, Turn-on methods of SCR, Commutation techniques of SCR - Natural Commutation & Load Commutation.
UNIT-II (10 Hrs)	**AC-DC Converters:** Introduction to Rectifiers, Operation and analysis of single-phase full-wave controlled rectifier circuit with R and RL load (continuous & discontinuous conduction), Effect of freewheeling diode. **DC-AC Converters:** Introduction to Inverters, Single phase half-bridge & full-bridge inverters, Total Harmonic Distortion.
UNIT-III (10 Hrs)	**DC-DC Converters:** Introduction, Classifications – buck and boost converters, Simple Problems. **AC-AC Converters:** Single phase AC voltage controller with R & RL loads, Single phase mid-point Cycloconverter operation - step-up & step-down.

UNIT-IV (10 Hrs)	**Battery Storage Systems:** Construction and Principle of operation of Standard Batteries: Lead–Acid (PbA) Battery, Valve regulated Lead acid battery (VRLA), Nickel–Cadmium (Ni–Cd), Modern Batteries: Nickel–Metal Hydride (Ni–MH), Lithium-Ion (Li-Ion), Flow Batteries: Vanadium Redox Flow Battery (VRFB), Zinc-Bromine Flow Battery, Iron-Chromium Flow Battery.
UNIT-V (10 Hrs)	**Battery Management System (BMS):** Introduction, Primary batteries and Secondary batteries, Battery terminology, Battery parameters - capacities, State of Charge (SOC) - Depth of Discharge (DOD) - State of Health (SOH), Applications of Batteries, Design of battery pack (Series & Parallel), BMS Functionality – Constant Current & Constant Voltage (CC&CV) charging, Regulators, Meters, Monitors, Balancers & Protectors.
Textbooks:	
1.	Power Electronics, Dr. P. S. Bimbhra, Khanna Publishers,7th Edition,2022.
2.	Davide Andrea, Battery Management Systems for Large Lithium-Ion Battery Packs, Artech, 2010.
Reference Books:	
1.	Power Electronics Handbook: Devices, Circuits and Applications by Muhammad H. Rashid, Academic Press Inc Publications, 2nd Edition,2006.
2.	Principles of Energy Storage Systems by P. Jayarama Reddy, B S Publications, 2023.
e-Resources:	
1.	https://nptel.ac.in/courses/108102145
2.	nptel.ac.in/courses/113105102

					Course Code: B23EEM301
		SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE (A)			**R23**
		III B.Tech. II Semester MODEL QUESTION PAPER			
		POWER CONVERSION SYSTEMS & BATTERY STORAGE			
		(Minor Degree course in EEE)			
Time: 3 Hrs.					**Max. Marks: 70 M**
		Answer Question No.1 compulsorily			
		Answer **ONE Question** from **EACH UNIT**			
		Assume suitable data if necessary			
					10 x 2 = 20 Marks
			CO	**KL**	**M**
1.	**a).**	What is latching current in SCR?	1	2	2
	b).	What is commutation in SCRs?	1	2	2
	c).	What is the purpose of a freewheeling diode in a rectifier circuit?	2	2	2
	d).	Define Total Harmonic Distortion (THD).	2	2	2
	e).	A step-down chopper has input voltage of 100V and duty ratio of 0.5. What is the output voltage?	3	3	2
	f).	What is a cycloconverter?	3	2	2
	g).	List of two applications of lithium-ion batteries.	4	3	2
	h).	Name the positive and negative electrodes used in a Ni–Cd battery.	4	2	2
	i).	What is the main difference between primary and secondary batteries?	5	2	2
	j).	Mention two applications of batteries in renewable energy systems.	5	3	2
					5 x 10 = 50 Marks
		UNIT-1			
2.	**a).**	**Sketch** the static V-I characteristics of an SCR and explain.	1	3	5
	b).	**Describe** various triggering methods used in SCR.	1	3	5
		OR			
3.	**a).**	**Sketch** the static V-I characteristics of a MOSFET and explain.	1	3	5
	b).	**Explain** natural and impulse commutation techniques of SCR with circuit diagrams.	1	3	5
		UNIT-2			
4.	**a).**	**Explain** the operation of a single-phase full-wave controlled rectifier with R-load. Draw input and output voltage waveforms & derive the average output voltage expression.	2	3	5
	b).	**Explain** the principle of sinusoidal PWM (SPWM) technique. Draw the carrier & modulating signals and resulting output waveform.	2	3	5
		OR			

5.	**a).**	**Discuss** the effect of a freewheeling diode in a full-wave controlled rectifier with RL-load. Explain with circuit and draw their waveforms.	2	3	5
	b).	**Describe** the working of a single-phase full-bridge inverter with R-load and draw the output waveforms.	2	3	5
		UNIT-3			
6.	**a).**	**Explain** the working of a step-down (buck) chopper with neat circuit diagram and derive the input-output voltage expression.	3	3	5
	b).	**Explain** the working of a single-phase AC voltage controller with RL-load with neat circuit diagram and waveforms.	3	3	5
		OR			
7.	**a).**	**Explain** the operation of a step-up (boost) chopper with circuit diagram and output waveforms. Derive the relation between input and output voltage.	3	3	5
	b).	**Explain** the principle and operation of a single-phase mid-point cycloconverter in step-down mode with necessary input and output waveforms.	3	3	5
		UNIT-4			
8.	**a).**	**Explain** the construction and working principle of a lead–acid battery with relevant reactions.	4	3	5
	b).	**Illustrate** the working principle of a vanadium redox flow battery by drawing a labeled diagram and applying the relevant redox reactions	4	3	5
		OR			
9.	**a).**	**Demonstrate** the charging and discharging process of a lithium-ion battery with a neat labeled diagram.	4	3	5
	b).	**Explain** the construction and operation of a Ni–MH battery with neat circuit diagrams.	4	3	5
		UNIT-5			
10.	**a).**	**Define** and explain the terms State of Charge (SOC), Depth of Discharge (DOD) and State of Health (SOH) with suitable illustrations.	5	3	5
	b).	**Explain** how to design a battery pack using series and parallel combinations for a specific voltage and capacity requirement with diagrams.	5	3	5
		OR			
11.	**a).**	**Explain** Constant Current–Constant Voltage (CCCV) charging technique with the help of a voltage-current graph.	5	3	5
	b).	What is the function of a Battery Management System (BMS)? **List** and **explain** its main functionalities.	5	3	5

CO-COURSE OUTCOME **KL-KNOWLEDGE LEVEL** **M-MARKS**

NOTE : Questions can be given as A,B splits or as a single Question for 10 marks

Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23EEM401	**Minor**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

ELECTRIC VEHICLE FUNDAMENTALS

(Minor Degree course in EEE)

Course Objectives: Students will learn about

1.	The basic concepts of EVs and vehicle dynamic modeling.
2.	The various configurations of EVs, HEVs and power train components.
3.	The various Energy storage systems for EVs and understand their characteristics.
4.	The drive systems of EVs and their control.
5.	The charging technology and infrastructure for EVs.

Course Outcomes: At the end of the course, the students will be able to

S.No	Outcome	Knowledge Level
1.	Explore the significance of electric vehicles and vehicle dynamic modeling.	K3
2.	Illustrate the configurations of electric vehicles and powertrain components.	K3
3.	Explore different energy storage systems for EVs and battery parameters.	K3
4.	Illustrate the PMSM and BLDC motor drives used in EVs.	K3
5.	Illustrate the charging technologies and infrastructure for EVs.	K3

SYLLABUS

UNIT-I (10Hrs)	**Introduction to Electric Vehicles and Modeling:** Introduction to Electric Vehicles (EV), EV History, EV Advantages, Comparisons of EV and Internal Combustion Engine vehicles, Vehicle Dynamics modeling with constant tractive effort, Propulsion System Design, Design Considerations, Overview of Basic electrical quantities and Systems: Electric Generator, Motor, Power Converters.
UNIT-II (10 Hrs)	**Architecture of EVs and Power Train Components:** Architecture of EVs and HEVs – Plug-in Hybrid vehicles (PHEV), Fuel cell EV, Power train components of EVs – EV Transmission Configurations, Transmission Components, Ideal Gearbox: Steady State Model.
UNIT-III (10 Hrs)	**Energy Storage Systems for EV:** Battery Basics, Different types, Battery Parameters, Importance of Lead Acid Batteries and Lithium Batteries (Li-ion, Li-Polymer), Battery Management system, Fuel cell, Super Capacitors, Fly Wheel.

UNIT-IV (10 Hrs)	**Electric Vehicle Motor Drives:** Electric Drive Components of EV, Permanent Magnetic Synchronous Motor (PMSM) Drive - Principle and Operation of PMSM, Block diagram representation and operation of PMSM Drive, Brushless DC (BLDC) Motor Drive - Principle and operation of BLDC Motor, Block diagram representation and operation of BLDC Motor Drive.
UNIT-V (10 Hrs)	**EV Charging Technology:** Overview of the EV battery charging system, Basic Requirements for Charging System, Infrastructure Needed for Charging Electric Vehicles, Charger Architecture, Charger Functions, EV Charging Standards, Schematics of V2G and V2V Technologies.
Textbooks:	
1.	Iqbal Husain, "Electric and Hybrid Vehicles Design Fundamentals", CRC Press, Taylor & Francis Group, 3rd Edition, 2021.
2.	John G. Hayes and A. Goodarzi, "Electric Powertrain – Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles" Wiley Publication, 1st Edition, 2018.
Reference Books:	
1.	James Larmine,John Lowry, "Electric Vehicles Technology Explained" Wiley Publication, 2nd Edition, 2012.
2.	Y. Gao, S. Gay and A. Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, CRC Press, 1st Edition,2005.
e-Resources:	
1.	https://nptel.ac.in/courses/108103009/
2.	https://nptel.ac.in/courses/108102121/

				Course Code: B23EEM401	
		SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE (A)			**R23**
		IV B.Tech. I Semester MODEL QUESTION PAPER			
		ELECTRIC VEHICLE FUNDAMENTALS			
		(Minor Degree course in EEE)			
Time: 3 Hrs.				**Max. Marks: 70 M**	
		Answer Question No.1 compulsorily			
		Answer **ONE Question** from **EACH UNIT**			
		Assume suitable data if necessary			
				10 x 2 = 20 Marks	
			CO	**KL**	**M**
1.	**a).**	Explain two factors that lead to the decline of EVs in the early 20th century.	**1**	**2**	**2**
	b).	Define tractive effort in vehicle dynamics?	**1**	**2**	**2**
	c).	State one advantage of using a fuel cell over a battery in EVs.	**2**	**2**	**2**
	d).	Explain the role of any two major components of an EV powertrain.	**2**	**2**	**2**
	e).	Explain the significance of **C-rate** in battery performance	**3**	**3**	**2**
	f).	How does BMS improve the safety and lifespan of a battery pack	**3**	**3**	**2**
	g).	Explain why PMSMs are widely used in Electric vehicles	**4**	**2**	**2**
	h).	Differentiate between trapezoidal and sinusoidal back EMF in BLDC motors.	**4**	**4**	**2**
	i).	Distinguish between onboard and off board EV chargers	**5**	**4**	**2**
	j).	Differentiate between V2G and V2V technologies.	**5**	**4**	**2**
				5 x 10 = 50 Marks	
		UNIT-1			
2.	**a).**	Describe how the basic components of an electric vehicle work together to enable operation.	**1**	**3**	**5**
	b).	Explain in detail Evolution of EVs from early developments to modern-days.	**1**	**3**	**5**
		OR			
3.	**a).**	Explain the concept of vehicle dynamics with constant tractive effort and derive the equation for vehicle acceleration.	**1**	**3**	**5**
	b).	Explain the role of electric generators, motors, and power converters in evs.	**1**	**3**	**5**
		UNIT-2			
4.	**a).**	Explain the operation of series Hybrid Electric Vehicle	**2**	**3**	**5**
	b).	Explain the working principle of a fuel cell used in an electric vehicle	**2**	**3**	**5**
		OR			
5.	**a).**	Discuss in detail about power train components in EV.	**2**	**3**	**5**
	b).	Compare fuel cell evs with battery evs in terms of efficiency, range, and infrastructure requirements.	**2**	**3**	**5**

		UNIT-3			
6.	**a).**	Explore the importance of Li-ion battery, explain its operation.	**3**	**3**	**5**
	b).	Illustrate battery specifications of EV.	**3**	**3**	**5**
		OR			
7.	**a).**	Explain Battery Management system with a neat sketch.	**3**	**3**	**5**
	b).	Explain the performance of Super Capacitors in Hybrid Electric Vehicles?	**3**	**3**	**5**
		UNIT-4			
8.	**a).**	Explain in detail the major electric drive components used in electric vehicles.	**4**	**3**	**5**
	b).	Illustrate the advantages and limitations of PMSM and BLDC motor in ev applications.	**4**	**3**	**5**
		OR			
9.	**a).**	Explain in detail the working and operation of BLDC drive in EV with block Diagram.	**4**	**3**	**10**
		UNIT-5			
10.	**a).**	Discuss the basic requirements of the Charging system.	**5**	**3**	**5**
	b).	Explain the infrastructure required for Charging evs.	**5**	**3**	**5**
		OR			
11.	**a).**	Discuss the schematics of V2G Technologies?	**5**	**3**	**5**
	b).	Discuss the potential benefits and challenges of V2G integration.	**5**	**3**	**5**

CO-COURSE OUTCOME **KL-KNOWLEDGE LEVEL** **M-MARKS**

NOTE : Questions can be given as A,B splits or as a single Question for 10 marks