**Regulation: R23**

## ELECTRICAL AND ELECTRONICS ENGINEERING (Honors)

### 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 |
|---|---|---|---|---|---|---|---|---|---|
| B23EEH101 | Electrical Machine Design | III-I | 3 | 3 | 0 | 0 | 30 | 70 | 100 |
| B23EEH201 | Power Quality & Enhancement | III-II | 3 | 3 | 0 | 0 | 30 | 70 | 100 |
| B23EEH301 | Advanced Power Electronics | IV-I | 3 | 3 | 0 | 0 | 30 | 70 | 100 |
| B23EEH401 | *MOOCS-I | III-I to IV-I | 3 | -- | -- | -- | -- | -- | 100 |
| B23EEH501 | *MOOCS-II | III-I to IV-I | 3 | -- | -- | -- | -- | -- | 100 |
| B23EEH601 | *MOOCS-III | III-I to IV-I | 3 | -- | -- | -- | -- | -- | 100 |
| | | **TOTAL** | **18** | **9** | **0** | **0** | **90** | **210** | **600** |

*Three 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 III Year I Semester to IV Year I Semester

| Course Code | Category | L | T | P | C | C.I.E. | S.E.E. | Exam |
|---|---|---|---|---|---|---|---|---|
| **B23EEH101** | **Honors** | **3** | **--** | **--** | **3** | **30** | **70** | **3 Hrs.** |

## ELECTRICAL MACHINE DESIGN

(Honors Degree course in EEE)

**Course Objectives: Students will learn about**

| | |
|---|---|
| 1. | The design basics and limitations of electrical machine design |
| 2. | The design of DC machine windings & dimensions |
| 3. | The design of transformer windings, core, cooling & insulation |
| 4. | The design of Induction Machine dimensions & windings |
| 5. | The design of Synchronous Machine dimensions & windings |

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

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | **Illustrate** the rating, magnetic circuits, limitations, heating and cooling aspects of DC & AC machines. | K3 |
| 2. | **Design** the armature, field windings and main dimensions of DC Machine. | K4 |
| 3. | **Design** the core, windings, insulation, cooling and dimensions of single phase and three phase transformers. | K4 |
| 4. | **Design** windings, air gap length, conductor size, stator and rotor dimensions of Induction Machines. | K4 |
| 5. | **Select** the number of slots, poles and develop winding diagrams for Synchronous Machines. | K4 |

## SYLLABUS

| | |
|---|---|
| **UNIT-I (10Hrs)** | **Fundamental Aspects of Electrical Machine Design:** Design of Machines, Design Factors, Limitations in Design, Basic Principles, specification, Ratings, Magnetic Circuits, magnetization curves, heating, cooling, temperature rise with short term rating. |
| **UNIT-II (10 Hrs)** | **D.C Machines:** Construction details, Armature, windings, Commutator, Design of output equation, Selection of No. of poles, Magnetic circuit and Magnetization curve. |
| **UNIT-III (10 Hrs)** | **Transformers:** Classification of Transformers, core construction, types of winding and design, cooling and insulation, Output of Transformer, output equation, ratio of iron loss to copper loss, relation between core area and weight of iron and copper, optimum design. |

| | |
|---|---|
| **UNIT-IV (10 Hrs)** | **Three phase Induction Machines:** Stator, stator frames, rotor, rotor windings, comparison of squirrel cage and wound rotors, slip rings, design of output equation, main dimensions, stator winding, design of squirrel cage rotor and wound rotor. |
| | |
| **UNIT-V (10 Hrs)** | **Three phase Synchronous Machines:** Output equation, main dimensions for salient and non-salient pole machines, armature windings and design, selection of stator slots, air gap length, design of rotor for salient pole and turbo alternators. |
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| | |
|---|---|
| **Textbooks:** | |
| 1. | Sawhney AK, “A Course in Electrical Machine Design”, Dhanpat Rai & Sons, 4th edition, 2017. |
| 2. | R.K. Agarwal “Principles of Electrical Machine Design” S.K. Kataria & Sons, 5th edition, 2014. |
| **Reference Books:** | |
| 1. | Clayton A.E., “The performance and design of D.C. Machines”, Published by Isaac Pitman and Sons Ltd, 1st edition. |
| 2. | Say MG, “The performance and design of A.C. Machines”, Published by Isaac Pitman and Sons Ltd, 3rd edition. |
| | |
| **e-Resources:** | |
| 1. | https://nptel.ac.in/courses/108106023 |

| | | | | | |
|---|---|---|---|---|---|
| **Course Code: B23EEH101** | | | | | |
| **SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE (A)** | | | | | **R23** |
| **III B.Tech. I Semester MODEL QUESTION PAPER** | | | | | |
| **ELECTRICAL MACHINE DESIGN** | | | | | |
| (Honors 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).** | List any two design factors considered in machine design. | **1** | **3** | **2** |
| | **b).** | What is the significance of heating in electrical machines? | **1** | **4** | **2** |
| | **c).** | What factors affect the design of the output equation of a DC machine? | **2** | **4** | **2** |
| | **d).** | Define magnetic reluctance in a DC machine. | **2** | **4** | **2** |
| | **e).** | What is the purpose of using laminated cores in transformers? | **3** | **4** | **2** |
| | **f).** | What is the significance of the ratio of iron loss to copper loss in transformer design? | **3** | **4** | **2** |
| | **g).** | What is the main difference between a squirrel cage rotor and a wound rotor? | **4** | **4** | **2** |
| | **h).** | Name any two factors that influence the main dimensions of an induction motor. | **4** | **4** | **2** |
| | **i).** | Why is the air gap length important in machine design? | **5** | **4** | **2** |
| | **j).** | What is the purpose of damper windings in a salient pole alternator? | **5** | **4** | **2** |
| | | | | | |
| **5 x 10 = 50 Marks** | | | | | |
| | | **UNIT-1** | | | |
| **2.** | **a).** | Write the limitations involved in designing electrical machines | **1** | **3** | **5** |
| | **b).** | Explain different methods for cooling of electrical machines? | **1** | **3** | **5** |
| | | **OR** | | | |
| **3.** | | State and explain the factors which govern the choice of specific magnetic loading and specific electric loading. | **1** | **3** | **10** |
| | | | | | |
| | | | | | |
| | | **UNIT-2** | | | |
| **4.** | **a).** | Derive the output equation of a DC Machine in terms of its main dimensions. | **2** | **4** | **5** |
| | **b).** | A 4-pole wave wound armature has 230 conductors and 23 Commutator segments. Give the table of winding connections in terms of coin sides. Choose a Retrogressive winding. | **2** | **4** | **5** |
| | | **OR** | | | |

| | | | | | |
|---|---|---|---|---|---|
| **5.** | **a).** | List out the procedure involved in the design of shunt field winding and series field winding. | **2** | **4** | **5** |
| | **b).** | A 4-pole, 25 HP, 500V, 600 rpm series motor has an efficiency of 82%. The pole faces are square and the ratio of pole arc to pole pitch is 0.67. Take Bav=0.58 wb/m2 and ac=17000 ampere conductors/meter. Obtain the main dimensions of the core. | **2** | **4** | **5** |
| | | | | | |
| | | **UNIT-3** | | | |
| **6.** | | Explain how heat generated in a transformer can be managed. Give a detailed scheme. | **3** | **4** | **10** |
| | | **OR** | | | |
| **7.** | | Derive an expression for output in KVA in terms of its main dimensions for 3-phase transformer. | **3** | **4** | **10** |
| | | | | | |
| | | **UNIT-4** | | | |
| **8.** | **a).** | Derive the output equation of an Induction motor. | **4** | **4** | **5** |
| | **b).** | Find the value of diameter and length of stator core of a 7.5KW, 220V, 50Hz, 4 pole, 3-phase induction motor for best power factor. Magnetic loading=0/4 wb/m2; Sp. Electric loading=22000A/m, Efficiency=0.86; power factor=0.87. core length/pole pitch= 1.0. | **4** | **4** | **5** |
| | | **OR** | | | |
| **9.** | **a).** | Write the rules for selecting stator and rotor slots of three phase slip ring induction motor? | **4** | **4** | **5** |
| | **b).** | Determine the main dimensions, no of turns per phase, conductor cross section and slot area of a 250 HP, 3phase ,50HZ, 400v, 1410 rpm slip ring induction motor. Assume specific magnetic loading Bav=0.5T, specific electric loading ac=30000 ampere conductors per meter, efficiency is 90%, winding factor is 0.955, current density is 3.5 A/sq mm. The slot space factor is0.4 and ratio of core length to pole pitch is 1.2. The machine is delta connected | **4** | **4** | **5** |
| | | | | | |
| | | **UNIT-5** | | | |
| **10.** | **a).** | Give the various factors to be considered for the selection of stator slots of a 3- phase alternator. | **5** | **4** | **5** |
| | **b).** | Determine the main dimensions of a 25 MVA, 50 Hz, 3-phase turbo alternator, given mean gap density=0.5 Tesla, specific electric loading of 550 ampere conductors per cm. of armature periphery; peripheral speed should not exceed 145 m/s; Air gap is 3 cm. | **5** | **4** | **5** |
| | | **OR** | | | |
| **11.** | | Give the developed view for the R-phase of a 3-phase, 4 pole, 24 slots, and star connected lap winding with coil short pitched by one slot. Each slot contains two coil sides. Phase sequence is RYB. | **5** | **4** | **10** |

**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

| Course Code | Category | L | T | P | C | C. I. E | S. E. E | Exam |
|---|---|---|---|---|---|---|---|---|
| B23EEH201 | Honor | 3 | -- | -- | 3 | 30 | 70 | 3 Hrs |

## POWER QUALITY ENHANCEMENT

(Honors Degree course in EEE)

**Course Objectives: Students will learn**

| | |
|---|---|
| 1. | About the significance of Power Quality improvement and standards |
| 2. | About Passive Shunt Series Compensators |
| 3. | About the Operation and Control of Active Shunt Compensators |
| 4. | About Active Series Compensators for Power Quality Enhancement |
| 5. | About analysis and Design of Unified Power Quality Compensators |

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

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | **Apply** the knowledge of Power Quality issues to explore and classify mitigation techniques. | K3 |
| 2. | **Illustrate** the Passive Shunt and Series Compensators for power quality enhancement | K3 |
| 3. | **Analyze** the Active Series Compensators for mitigation of power quality issues | K4 |
| 4. | **Analyze** the topologies and operation of Active Shunt Compensators | K4 |
| 5. | **Analyze** the working of Unified Power Quality Compensators | K4 |

## SYLLABUS

| | |
|---|---|
| **UNIT-I (10 Hrs)** | **Characterization of Electric Power Quality:** Power Quality Terms and Definitions -Transients, Short Duration Voltage Variations, Long Duration Voltage variations, Voltage Imbalance, Waveform Distortion, Voltage Fluctuations, Power Frequency Variations, Power Acceptability Curves, Impacts of Power Quality Problems on End Users, Power Quality Standards and Power Quality Monitoring. |
| **UNIT-II (10 Hrs)** | **Passive Shunt and Series Compensation:** Introduction, state of the art on passive shunt and series compensators, classification and principle of shunt and series compensators, Analysis and Design of single-phase passive shunt compensators for power factor correction, Simple Numerical Problems. |
| **UNIT-III (10 Hrs)** | **Active Shunt Compensation:** Introduction, Classification of DSTATCOMs, Principle of Operation and Control of DSTATCOMs (single-phase PQ and DQ theory-based control algorithms), Analysis and Design of DSTATCOMs. |

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|---|---|
| **UNIT-IV (10 Hrs)** | **Active Series Compensation:** Introduction, Classification of Active Series Compensators, Principle of Operation and Control of Active Series Compensators-Synchronous reference frame theory-based control, Analysis and Design of Active Series Compensators |
| | |
| **UNIT-V (10 Hrs)** | **Unified Power Quality Compensators:** Introduction, State of the Art on Unified Power Quality Compensators, Classification of Unified Power Quality Compensators, Principle of Operation and Control of Unified Power Quality Compensators - Synchronous reference frame theory-based control, Analysis and Design of Unified Power Quality Compensators. |
| | |
| **Text Books:** | |
| 1. | Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, “Power Quality Problems and Mitigation Techniques” Wiley Publications, 2015. |
| 2. | Power Quality Enhancement Using Custom Power Devices – Power Electronics and Power Systems, Gerard Ledwich, Arindam Ghosh, Kluwer Academic Publishers, 1st ed,2002. |
| | |
| **Reference Books:** | |
| 1. | Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M H J, First Edition, IEEE Press; 2000. |
| 2. | Instantaneous Power Theory and Applications to Power Conditioning, Hirofumi Akagi, Edson Hirokazu Watanabe, Mauricio Aredes, A John Wiley & Sons, INC., Publications, 2007. |
| **e-resources:** | |
| 1. | Power Quality- https://nptel.ac.in/courses/108102179 |
| 2. | Power Quality Enhancement - nptel.ac.in/courses/108107157 |

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|---|---|---|---|---|---|
| | | | | | **Course Code: B23EEH201** |
| **SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE (A)** | | | | | **R23** |
| **III B.Tech. II Semester MODEL QUESTION PAPER** | | | | | |
| **POWER QUALITY ENHANCEMENT** | | | | | |
| (Honors 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).** | Define power quality. | **1** | **2** | **2** |
| | **b).** | Explain the major power quality issues in power systems? | **1** | **2** | **2** |
| | **c).** | Explain the effect of shunt capacitors on power systems? | **2** | **2** | **2** |
| | **d).** | Give the limitations of passive compensation techniques? | **2** | **2** | **2** |
| | **e).** | Explain the role of the DC link capacitor in a DSTATCOM? | **3** | **2** | **2** |
| | **f).** | Which type of converter is commonly used in DSTATCOMs? Why? | **3** | **2** | **2** |
| | **g).** | Give the classification of Active Series Compensation | **4** | **2** | **2** |
| | **h).** | Explain the purpose of series compensation in power systems? | **4** | **2** | **2** |
| | **i).** | Give the classification of Unified Power Quality Compensators | **5** | **2** | **2** |
| | **j).** | Differentiate between UPQC–Q and UPQC–P | **5** | **2** | **2** |
| | | | | | |
| | | | | | **5 x 10 = 50 Marks** |
| | | **UNIT-1** | **CO** | **KL** | **M** |
| **2.** | **a).** | Classify the general power quality problems and explain | **1** | **3** | **5** |
| | **b).** | Explain how end user equipment are affected by power quality problems | **1** | **3** | **5** |
| | | **OR** | | | |
| **3.** | **a).** | Illustrate briefly about the following power quality problems<br>A) Long duration variations B) Voltage unbalance C) Power Frequency Variations | **1** | **3** | **5** |
| | **b).** | Explain the overview of mitigation methods of power quality | **1** | **3** | **5** |
| | | | | | |
| | | **UNIT-2** | | | |
| **4.** | **a).** | Compare series and shunt compensation | **2** | **3** | **5** |
| | **b).** | Illustrate the design of Shunt Compensators for Power Factor Correction | **2** | **3** | **5** |
| | | **OR** | | | |
| **5.** | **a).** | **Explain** the principle of operation of passive shunt compensation | **2** | **3** | **5** |
| | **b).** | A single-phase load having ZL=(4.0 +*j*1.0) pu is fed from an AC | **2** | **3** | **5** |

| | | | | | |
|---|---|---|---|---|---|
| | | supply with an input AC voltage of 230V at 50 Hz and a base impedance of 4.15 Ω. It is to be realized as a unity power factor load on the AC supply system using a shunt connected lossless passive element (L or C).<br>**Calculate** (a) the value of the compensator element (in farads or Henries) and (b) equivalent resistance (in ohms) of the compensated load. | | | |
| | | | | | |
| | | **UNIT-3** | | | |
| **6.** | **a).** | Explain the design procedure of Shunt Compensators for Power Factor Correction. | **3** | **4** | **5** |
| | **b).** | Classify DSTACOMs | **3** | **4** | **5** |
| | | **OR** | | | |
| **7.** | **a).** | Explain the operation of DSTATCOM used for sag mitigation | **3** | **4** | **5** |
| | **b).** | Illustrate the control of DSTACOM with single phase PQ theory-based control algorithm | **3** | **4** | **5** |
| | | | | | |
| | | **UNIT-4** | | | |
| **8.** | **a).** | Explain synchronous reference frame-based control strategy for DVR | **4** | **4** | **5** |
| | **b).** | Explain the state of art on Active Series Compensators | **4** | **4** | **5** |
| | | **OR** | | | |
| **9.** | **a).** | Classify different types of series active compensators | **4** | **4** | **5** |
| | **b).** | Explain the design procedure of DVR | **4** | **4** | **5** |
| | | | | | |
| | | **UNIT-5** | | | |
| **10.** | **a).** | Give the classification of Unified Power Quality Compensators | **5** | **4** | **5** |
| | **b).** | Explain the design procedure of UPQC | **5** | **4** | **5** |
| | | **OR** | | | |
| **11.** | | Explain the Synchronous Reference Frame theory-based control of UPQCs | **5** | **4** | **10** |

**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

| Course Code | Category | L | T | P | C | C. I. E | S. E. E | Exam |
|---|---|---|---|---|---|---|---|---|
| **B23EEH301** | **Honor** | **3** | **--** | **--** | **3** | **30** | **70** | **3 Hrs** |

## ADVANCED POWER ELECTRONICS

(Honors Degree course in EEE)

**Course Objectives: Students will learn about**

| | |
|---|---|
| 1. | The working principle, types and applications of non-isolated converters. |
| 2. | The modelling techniques for DC-DC converters using state-space, circuit averaging, and canonical models to derive converter transfer functions. |
| 3. | The working principle, types and applications of isolated converters. |
| 4. | The design of power electronic converters to improve power quality. |
| 5. | The Modulation techniques for Inverters. |

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

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | **Analyze** non-isolated converter topologies and determine the input-output voltage relationships. | K4 |
| 2. | **Model** and derive transfer functions of buck, boost, and buck-boost converters using various averaging and canonical modeling techniques. | K4 |
| 3. | **Analyze** isolated converter topologies and determine the input-output voltage relationships for various transformer-isolated DC-DC converters. | K4 |
| 4. | **Analyze** multi-pulse AC-DC converters, power factor improvement techniques. | K4 |
| 5. | **Explore** various modulation techniques used for inverters. | K4 |

## SYLLABUS

| | |
|---|---|
| **UNIT-I (10 Hrs)** | **Non-isolated DC-DC Converters:** Buck, Boost, Buck-boost in DCM and CCM modes - Relationship between input and output voltages, Design of critical inductance and capacitance for Buck, Boost and Buck-boost converters. |
| **UNIT-II (10 Hrs)** | **Modelling of Non-isolated DC-DC Converters:** Average switch model and Averaged state space model for buck, boost and buck-boost converters. |
| **UNIT-III (10 Hrs)** | **Isolated DC-DC converters:** Forward, Fly-back & Push-pull converters in DCM and CCM modes - Relationship between input and output voltages. |

| | |
|---|---|
| **UNIT-IV (10 Hrs)** | **Front-End (AC-DC) Converters:** Multi-pulse converters 6 & 12 pulse converters, Phase shifting transformers, Conventional methods of power factor improvements: Semi-converter, Extinction angle control, Symmetrical angle control – active front-end converters - Single phase: Boost PWM rectifiers. |
| | |
| **UNIT-V (10 Hrs)** | **Modulation Techniques:** Three-phase Two level H-Bridge Inverter - Sinusoidal pulse width modulation (SPWM), Third Harmonic Injected SPWM, Space Vector PWM (SVPWM).<br>Three-phase Five level cascaded H-Bridge Inverter – Phase Disposition (PD), Phase Opposition Disposition (POD), Alternate Phase Opposition Disposition (APOD) carrier modulation schemes with SPWM Technique. |
| | |
| **Text Books:** | |
| 1. | Ned Mohan, Undeland and Robbin, 'Power Electronics: converters, Application and design', John Wiley and sons.Inc, Newyork, 2nd Edition, 1995. |
| 2. | Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, 4th Edition, New Delhi 2017. |
| | |
| **Reference Books:** | |
| 1. | Erickson R W,' Fundamentals of Power Electronics', Chapman and Hall, 2nd Edition, 2004. |
| 2. | Hart, Daniel W., and Daniel W. Hart. Power electronics. New York: McGraw-Hill, 2010. |
| **e-resources:** | |
| 1. | [nptel.ac.in/courses/108107128](nptel.ac.in/courses/108107128) |
| 2. | [nptel.ac.in/courses/108108035](nptel.ac.in/courses/108108035) |

**Course Code: B23EEH301**

| | |
|---|---|
| **SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE (A)** | **R23** |

**IV B.Tech. I Semester MODEL QUESTION PAPER**

**ADVANCED POWER ELECTRONICS**

(Honors 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).** | Derive the output voltage relation for Buck converter | **1** | **2** | **2** |
| | **b).** | How does the polarity of output voltage in a buck-boost converter differ from that of a buck converter? | **1** | **2** | **2** |
| | **c).** | What is meant by the average switch model of a converter? | **2** | **2** | **2** |
| | **d).** | Write the state variables commonly used in modeling DC-DC converters. | **2** | **2** | **2** |
| | **e).** | State the applications of Flyback converter | **3** | **2** | **2** |
| | **f).** | Derive input and output voltage for forward converter | **3** | **2** | **2** |
| | **g).** | What is the purpose of a phase-shifting transformer in a multi-pulse converter? | **4** | **2** | **2** |
| | **h).** | What is the advantage of using a 12-pulse converter over a 6-pulse converter? | **4** | **2** | **2** |
| | **i).** | Distinguish the difference between PD, POD and APOD? | **5** | **2** | **2** |
| | **j).** | Explain the advantages of space vector compared SPWM | **5** | **2** | **2** |

**5 x 10 = 50 Marks**

| | | | | | |
|---|---|---|---|---|---|
| | | **UNIT-1** | | | |
| **2.** | | Derive the critical value of inductance and capacitance for Boost Converter | **1** | **3** | **10** |
| | | **OR** | | | |
| **3.** | | Derive the critical value of inductance and capacitance for Buck-Boost Converter | **1** | **3** | **10** |
| | | | | | |
| | | **UNIT-2** | | | |
| **4.** | | Explain the average state space model for Buck converter | **2** | **3** | **10** |
| | | **OR** | | | |
| **5.** | | Explain the average state space model for Boost converter | **2** | **3** | **10** |
| | | | | | |
| | | **UNIT-3** | | | |
| **6.** | | Explain the operation of Flyback converter in continuous conduction | **3** | **3** | **10** |

| | | | | | |
|---|---|---|---|---|---|
| | | mode | | | |
| | | **OR** | | | |
| **7.** | | Explain the operation of Push-Pull converter in continuous conduction mode | **3** | **3** | **10** |
| | | | | | |
| | | **UNIT-4** | | | |
| **8.** | | Briefly explain the conventional methods for power factor improvement? | **4** | **3** | **10** |
| | | **OR** | | | |
| **9.** | | Explain the operation of 12 pulse converter with neat diagrams | **4** | **3** | **10** |
| | | | | | |
| | | **UNIT-5** | | | |
| **10.** | | Explain space vector pulse width modulation technique for 3 phase two level inverter. | **5** | **3** | **10** |
| | | **OR** | | | |
| **11.** | | Explain three phase five level cascaded MLI with APOD carrier based SPWM technique with necessary waveforms. | **5** | **3** | **10** |

**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