GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3162419
Semester – VI
Subject Name: Principles of Power Supply

Type of course: Professional Core Course

Prerequisite: Circuit Theory, Basic Power Electronics Devices, Analog and Digital Electronics, Circuits and Applications, Power Electronics Circuits-1, Power Electronics in Consumer Products

Rationale: Modern electronics and electrical equipment require power supply with different voltage, current and frequency ratings. The conventional AC power supply thus needs to be converted to an alternate AC or DC source dependent on the application, which requires the integration of various power electronic converters and control strategies. This course gives a brief overview of various power supplies, components and converters used therein and their applications.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	Weightage (%)
1	**Unregulated DC Power Supply:** • Introduction – Requirement of Power Supply with Modern Applications, Review of Rectifier circuits. • Performance Parameters for DC Power Supply. • Filters: Input Capacitor filter, Inductor filter, L-C filter, R-C filter, C-L-C filter, selection of filter components. • Transformer less power supply • Major Issues Arising due to Various Power Supplies – Reliability of Power Supply – Advantages and Disadvantages • Selection of Power Supply Based on Application.	**8**	**15**
2	**Regulated Linear DC Power Supply:** • Types of regulated DC power Supplies, Basic block diagram. Performance parameters • Shunt Regulators using Zener diode, transistor etc., Series pass Transistor regulator, Op-amp based regulator circuit, Comparator based linear power supply, current limiting, Constant voltage operation, constant current operation, Protections • Current regulators and applications • voltage reference and current reference • Power supply design and components selection	**8**	**15**
3	**Linear Reference ICs and Regulated DC Power Supply ICs:** • General purpose voltage regulator LM 723, its block diagram, Operating principle, regulated power supply using LM 723, current limiting and current fold back, negative voltage regulator. • Voltage reference TL 431, current reference REF200 etc. • Fixed and adjustable voltage regulator ICs for +ve and -ve output voltage (e.g. LM 78XX, LM 79xx, LM 317, LM 337), Low Drop Out (LDO) voltage	**8**	**20**

	regulators, working, importance, LDO ICs (e.g. LM1117, MIC5504) • Design of simple regulated power supplies based on various ICs mentioned above, Constant, and variable current regulator circuits using voltage regulator IC, OPAMP etc.		
4	**Switched Mode Power Supplies:** • Switching power supply fundamentals, Types - Non isolated and isolated- Linear versus SMPS – Review of common switching power supply topologies: Buck, Boost, Buck-Boost, Cuk, SEPIC, Forward, Flyback, Push-Pull, Half and Full Bridge, Multiphase buck converter • Selection of control method – choice of semiconductors – frequency and magnetic components selection – PCB layout precautions – losses and stresses in SMPS – techniques to improve efficiency in SMPS • SMPS control ICs (e.g. UA384x, LM3524, MC34063, MC33363, LM5155x, A5970)	**10**	**25**
5	**Batteries and Battery based Power Supplies:** • Introduction: Operation of Battery, Basic Types, Primary and Secondary, Cell Discharge and Charge, Battery Life. • Battery types: Primary: Zinc, Lithium and Secondary, Rechargeable batteries: Lead Acid, Ni-Cd and Ni-MH, Li-ion, Li-Fe and Li-Po, Alkaline • Charging Methods: Constant current charging, Constant voltage charging, Taper current charging, Constant current constant voltage charging. • Power supply for Portable Electronics Equipment • Battery based AC Power Supplies – UPS – Types - Applications	**10**	**25**

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**30**	**15**	**20**	**10**	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

1. **Remembering:** Retrieving, recognizing, and recalling relevant knowledge from long-term memory.
2. **Understanding:** Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.
3. **Applying:** Carrying out or using a procedure for executing or implementing.
4. **Analyzing:** Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing.
5. **Evaluating:** Making judgments based on criteria and standards through checking and critiquing.
6. **Creating:** Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing.

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1 Power Electronics: Converters, Applications and Design, Mohan, Undeland and Robbins, Wiley India
2 Power Electronics Handbook by M H Rashid, Academic Press
3 Power Electronics: Circuits, Devices and Applications, Third edition by M. H. Rashid, PHI.

4 Linden's Handbook of Batteries by David Linden & Thomas B. Reddy, Fourth Edition, TMH.
5 Understanding Batteries by Dell & Rand, RSC Paperbacks
6 Power Electronics by M. S. Jamil Asghar, PHI.
7 Power Electronics by Philips T. Krein, Oxford.
8 The Power Electronics Handbook by T L Skvarenina, CRC Press

Course Outcomes:

Sr. No.	CO statement At the end of this course, students will demonstrate the ability to	Topics Mapped	Marks % weightage
CO-1	Illustrate the principle and functioning of various power supplies.	1, 2, 3, 4, 5	20%
CO-2	select appropriate components for various types of power supplies and identify topologies used in it.	1, 2, 3, 4, 5	30%
CO-3	select appropriate type of power supply, test and troubleshoot it for a given application.	1, 2, 3, 4, 5	30%
CO-4	differentiate various batteries and select proper charging and power supply circuit for the same.	1, 2, 3, 4, 5	20%

Suggested List of Experiments:

1. To study unregulated DC power supply.
2. To study Zener based regulated power supply.
3. To study series pass transistor regulator-based power supply.
4. To study constant voltage / constant current DC power supply.
5. To study IC 723/78xx/79xx based power supply.
6. To study LM317/LM1117/MIC5504, etc. based regulated power supply.
7. To study Buck/Boost based switched power supply.
8. To study Forward converter based switched power supply.
9. To study Flyback converter based switched power supply.
10. To study Cuk /SEPIC converter based switched power supply.
11. To study buck/boost converter IC (like LM2596, MC34063, XL6009 etc.) based power supplies.
12. To study charging circuits for Lead Acid batteries
13. To study charging circuit for Li-Ion/Li-Po batteries.
14. To study the block diagram of Online/Offline UPS
15. To study single phase UPS design based on various manufacturers like Infineon, ST, TI, Analog Electronics, etc.

(e.g. https://www.ti.com/solution/single-phase-online-ups, https://www.infineon.com/cms/en/applications/solutions/power-supplies/uninterruptible-power-supply-ups)

Major Equipment:

Oscilloscope, Isolated Channel Power Scope, Power Converter Trainer Kits, Multi-meters, Variable Power Supply, Programmable Digital Power Supply etc.

List of Open Source Software/learning website:

- **Open Source Software:**
  - TINA-TI for circuit simulation (http://www.ti.com/tool/tina-ti)
  - OSCAD for CAD application (http://www.oscad.in/downloads)
  - Fritzing for bread board/GP board wiring planning (http://fritzing.org/download)
- **Web-based tools for reference/design:**
  - http://www.fairchildsemi.com/support/design-tools/power-supply-webdesigner/
  - https://gradeup.co/power-supplies-i-dfc4c81d-c5c6-11e5-9a8b-47d8413e1875

- https://techweb.rohm.com/knowledge/acdc/acdc_pwm/acdc_pwm01/812
- https://www.acopian.com/linear-power-supplies.html
- http://www.ti.com/lsds/ti/analog/webench/overview.page
- https://powersupply33.com/
- http://www.skillbank.co.uk/psu/
- http://www.physics.unlv.edu/~bill/PHYS483/power_supply_info.pdf
- https://www.instructables.com/Regulated-Linear-DC-Power-Supply/
- https://www.onsemi.com/pub/Collateral/SMPSRM-D.PDF
- https://www.electronics-tutorials.ws/power/switch-mode-power-supply.html
- https://www.electronicdesign.com/power-management/article/21798375/7-critical-steps-in-switching-power-supply-design
- https://www.autodesk.com/products/eagle/blog/linear-regulated-vs-switch-mode-power-supply/
- https://www.sealedperformance.com.au/wp-content/uploads/2015/09/1277751263_20100627-TechManual-Lo.pdf
- https://en.wikipedia.org/wiki/Power_supply#Switched-mode_power_supply

- **Open source for Math Tools:**
  - http://maxima.sourceforge.net/
  - http://www.sagemath.org/
  - http://www.scilab.org/
  - http://www.gnu.org/software/octave/
- **Learning website:**
  - http://nptel.iitm.ac.in/courses.php
  - http://ocw.mit.edu/
  - https://swayam.gov.in/
  - http://www.datasheetcatalog.com/
  - http://www.electrical-engineering-portal.com