Reg. No										

AY 24

Gandhi Institute of Engineering and Technology University, Odisha, Gunupur
(GIET University)

M.Tech. (First Semester – Regular/Supplementary) Examinations, January – 2026

24MPEPE11011 – Power Quality

Time: 2 hrs | Maximum: 60 Marks

Answer ALL questions

(The figures in the right hand margin indicate marks)

PART – A **(2 x 5 = 10 Marks)**

Q.1. Answer ***ALL*** questions		CO #	Blooms Level
a.	What is Total Harmonic Distortion (THD)?	CO1	K1
b.	How do shunt capacitor banks affect harmonic resonance?	CO2	K2
c.	What is passive power factor correction? Give one example.	CO4	K2
d.	What is a Model Reference Adaptive System (MRAS)?	CO3	K2
e.	What is a power acceptability curve?	CO1	K2

PART – B **(10 x 5 = 50 Marks)**

Answer ***ALL*** the questions		Marks	CO #	Blooms Level
2. a.	A 230 V, 50 Hz supply feeds a load where the measured RMS line voltage is 230 V and the fundamental RMS is 220 V. Compute the voltage THD and comment on the power quality at the bus.	5	CO1	K3
b.	A nonlinear load draws a current composed of fundamental component 40 A and 5th and 7th harmonic components of 10 A and 6 A respectively (all RMS). Calculate the Total Harmonic Distortion (THD) of the current.	5	CO1	K3
	(OR)			
c.	Explain harmonic resonance phenomena in power systems, including series and parallel resonance, and discuss how impedance scan analysis is used to detect them.	5	CO1	K4
d.	With block diagram and waveforms, explain the operation and control of a single-phase active PFC front-end converter operating in continuous conduction mode.	5	CO1	K4
3.a.	Discuss a systematic approach to building a comprehensive model of a distribution network with linear and non-linear loads for harmonic analysis.	5	CO2	K4
b.	Explain how harmonic flow studies are carried out using network models and what outputs are typically examined by engineers.	5	CO2	K3
	(OR)			
c.	Describe mitigation strategies at the system and load levels to reduce power quality problems caused by non-sinusoidal currents.	5	CO2	K4
d.	A 400 V, 50 Hz system has a shunt capacitor bank of 150 kvar connected at a bus where the 5th harmonic line-to-line voltage magnitude is 30 V (RMS). The capacitive reactance at 50 Hz is 20 Ω. Assuming the reactance scales inversely with frequency, calculate the 5th harmonic current through the capacitor bank.	5	CO2	K3
4.a.	Explain the structure and operation of three-phase APFC converters and compare them with single-phase counterparts in terms of performance and complexity.	5	CO3	K4

b.	Describe PFC schemes based on bilateral single-phase and three-phase converters and highlight their advantages in improving input current quality.	5	CO3	K4
	(OR)			
c.	Discuss design considerations for PFC stages in power electronic equipment, including selection of topology, switching frequency, control method and compliance with standards.	5	CO3	K5
d.	A 400 V, 50 Hz three-phase load draws 100 kW at a power factor of 0.7 lagging. Calculate the reactive power compensation required to improve the power factor to 0.95 lagging and find the rating of capacitor bank in kvar.	5	CO3	K3
5.a.	Explain the concept of variable-structure control and sliding modes and show how they can be used in designing robust active power filters.	5	CO4	K4
b.	An active power filter is designed to compensate a 30 A RMS 5th harmonic and 18 A RMS 7th harmonic. If the DC-link voltage is 700 V and switching losses are neglected, estimate the minimum VA rating required for the filter converter (assume it only handles harmonic current).	5	CO4	K4
	(OR)			
c.	A variable-structure controller for a DSTATCOM is tuned such that the closed-loop current response has a settling time of 5 ms and a damping ratio of 0.7. Compute the approximate natural frequency of the equivalent second- order system and comment on its suitability for 50 Hz operation.	5	CO4	K3
d.	Explain the Hamilton–Jacobi–Bellman equation and describe its significance in the formulation of optimal control laws for power quality compensators.	5	CO4	K4
6.a.	Discuss different control strategies for single-phase APFC converters such as average current mode control and peak current mode control.	5	CO1	K4
b.	A 100 kVA, 11 kV/0.415 kV transformer supplies a nonlinear load drawing 80 kVA at 0.8 pf (fundamental). The current THD is 20%. Determine the apparent kVA seen by the transformer and comment on its loading margin.	5	CO2	K4
	(OR)			
c.	A single-phase APFC boost converter operates from 230 V, 50 Hz mains and delivers 1.5 kW at 400 V DC. Assuming ideal operation and unity power factor, calculate the RMS input current and determine the approximate input current peak if it follows a sinusoidal waveform.	5	CO4	K3
d.	Describe the structure and working of a MRAS-based controller and explain how it can be applied to control a static VAR compensator (SVC).	5	CO3	K4

--- End of Paper ---