

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)**

CLASS: MTECH.
BRANCH: EE

SEMESTER : II
SESSION : SP/2025

SUBJECT: EE599 DIGITAL POWER SYSTEM PROTECTION

TIME: 3 Hours

FULL MARKS: 50

INSTRUCTIONS:

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

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| | CO | BL |
| Q.1(a) Analyze the operation of the individual parts of the digital relay with suitable block diagram [6] | CO1 | 1 |
| Q.1(b) Consider a signal $x(t) = \sin(2\pi \cdot 50t) + \sin(2\pi \cdot 250t)$ acquired by the digital relay, and subsequently sampled at 100 Hz, 200 Hz, 300Hz, 400 Hz respectively, analyze if any erroneous effect will be observed in the sampled signal with proper justification. [4] | CO1&
CO2 | 3&4 |
| Q.2(a) Estimate the phasor values of fundamental component of $i(t)$ by digital relay, using Recursive DFT which is sampled at 800 Hz ($f_0 = 50$ Hz), when the phasor value of the 1 st window is $10 \angle 0^\circ$. [5] | CO3 | 3&4 |

$$i(t) = 2 + 10 \times \cos(2\pi f_0 t) + 3 \times \cos\left(3 \times 2\pi f_0 t + \frac{\pi}{4}\right) + 1 \times \cos\left(5 \times 2\pi f_0 t + \frac{\pi}{2}\right)$$

Sample number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
$i(n)$	14.1	9.2	6.8	5.1	3.1	1.3	-4.4	-10.9	-10.1	-5.2	-2.8	-1.1	0.9	2.7	8.4	14.9	14.1	9.2	6.8	5.1	3.1	1.3	-4.4	-10.9

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| Q.2(b) Derive the phasor estimation phenomena using LES technique, in digital relays and analyze its advantages over other phasor estimation technique. [5] | CO3&
CO4 | 2 |
| Q.3(a) A three-phase transformer with rated capacity 1500 MVA, voltage rating on HV side at nominal tap : 765 kV, LV side voltage : 400 kV. Tapping ratios (+ 5.50%) to (- 5.50%) in steps of 11. CT ratio on HV side 2000:1 and on LV side CT ratio is 3000:1. In order to protect the transformer, the provided Digital differential relay is with following settings as provided by manufacturer: $I_{P.U.} = 0.2$, Slope $K_1 = 0.2$, Slope $K_2 = 0.6$, $I_{High-set Differential} = 8$ P.U., $I_{RT1} = 1$ P.U., $I_{RT2} = 4$ P.U.. Judge if the settings are correct and relay does not maloperate when the transformer is operating at (i) highest tap (ii) lowest tap. [5] | CO3 | 5 |
| Q.3(b) Identify and analyze the field ground fault protection of synchronous generator. [5] | CO3 | 2&3 |
| Q.4(a) Analyze the carrier aided protection phenomena for pre-acceleration of zones in three zone protection phenomena of transmission lines. Estimate the benefit of this methodology in SIPS. [5] | CO3&
CO4 | 3 |
| Q.4(b) Derive the operating relay torque equation for impedance relay and Mho relay and judge how they will behave during (1) arcing fault condition and (ii) power swing within the power system network. [5] | CO3 | 2 |
| Q.5(a) Identify the permissible errors observed by phasor measurement units required for system integrity protection scheme. Analyze how these errors are estimated. [5] | CO4 | 2&3 |
| Q.5(b) Analyze the different protection issues faced by AC-Microgrid. [5] | CO5 | 3 |