



SCHOOL OF COMPUTING AND ENGINEERING SCIENCES

MASTER OF SUSTAINABLE ENERGY TRANSITION

END OF SEMESTER EXAMINATION

MSSET 8103: POWER SYSTEMS FUNDAMENTALS

Date: 19th August 2024

Time: 18:00-20:30 Hours

Instructions

1. This examination consists of **FOUR** questions.
2. Answer **Question ONE (COMPULSORY)** and any other **TWO** questions.

Question 1 (20 marks)

1. Explain the concept of reactive power in single phase and three phase circuits. (2 marks)
2. As per the guest lecture in Power System Planning and Development, describe the types of financing applied in development of power generation capacity expansion projects. (4 marks)
3. Draw a single line diagram showing a typical distribution system.(3 marks)
4. Explore the roles of regulatory agencies, developers, financiers, and academic institutions in accelerating solar PV adoption in East Africa. Propose strategies to foster effective partnerships and knowledge sharing.(5 marks)
5. Discuss how the principles of decarbonization, decentralization, democratisation, and digitalization can be applied to Kenya's energy sector to achieve a sustainable energy transition. Provide specific examples of policies, technologies, or projects that illustrate each 'D' and their potential impact on energy access, affordability, and environmental sustainability in the country (6 marks)

Question 2 (15 marks)

1. Derive the relationship between voltage, current, power, and power factor using the power triangle.(3 marks)
2. Kenya buys power from Ethiopia, and it is delivered by a 500 KV DC line. Explain why a High Voltage DC line was chosen instead of a conventional AC system. (3 marks)

3. The Amboseli Lodge off grid case study demonstrated the potential of solar PV and battery storage in remote locations. Discuss the technical and economic feasibility of replicating this model in other off-grid contexts, considering factors like load profiles, solar resource availability, and battery technology advancements, PPA or EPC. (9 marks)

Question 3 (15 marks)

1. Are three-phase power systems less efficient than single-phase systems for transmitting the same amount of power? Explain why. (2 marks)
2. Explain the concept of “merit order” in dispatching power in a country. (3 marks)
3. With regards to the energy sector in Kenya, what are the differences between a white paper, a position paper, policies and regulations such as Acts of Parliament? (4 marks)
4. A single-phase AC circuit has a voltage of 120 V (rms) and a current of 10 A (rms). The power factor is 0.8 lagging. Calculate:
 - (a) The real power delivered in Watts. (2 marks)
 - (b) The reactive power delivered in VAR. (2 marks)
 - (c) The apparent power delivered in VA. (2 marks)

Question 4 (15 marks)

1. What does a low power factor in a power system indicate? (3 marks)
2. Describe the challenges associated with integrating a large-scale solar farm into the existing power grid(5 marks)
3. A generating station has the following daily load cycle :

Time (Hours)	0—6	6—10	10—12	12—16	16—20	20—24
Load (MW)	20	40	60	50	80	60

Draw the load curve and find(7 marks):

- i. maximum demand
- ii. units generated per day.
- iii. average load