



UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF CHEMICAL AND BIO-ENGINEERING TECHNOLOGY

FINAL EXAMINATION
OCTOBER 2025 SEMESTER

COURSE CODE : CPB40003
COURSE TITLE : INTRODUCTION TO RENEWABLE ENERGY
PROGRAMME NAME : BACHELOR OF CHEMICAL ENGINEERING TECHNOLOGY
(PROCESS) WITH HONOURS
DATE : 27 JANUARY 2026
TIME : 9:00AM - 12:00PM
DURATION : 3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consist of TWO sections.
4. Answer ALL questions for Section A.
5. Section B consist of four questions. Answer THREE (3) questions only.
6. Please write your answer on the answer booklet provided.
7. Please answer all questions in English only.
8. Please answer MCQ/EMQ questions using OMR sheet. ☐ *Tick if applicable*
9. Refer to the attached Formula/ Appendices. ☐ *Tick if applicable*

SECTION A (Total: 40 marks)

Answer ALL questions.

Please use the answer booklet provided.

1. Indicate the main reason solar power generation contributes to Malaysia's net-zero target.
 - A. Depend on fossil fuel backup
 - B. Produce no direct carbon emissions during operation
 - C. Increase land-use emissions
 - D. Offset emissions through carbon trading

2. State the National Energy Transition Roadmap (NETR).
 - A. Balance energy security, affordability, and sustainability
 - B. Eliminate renewable energy deployment
 - C. Prioritize fossil fuel subsidies
 - D. Increase coal dependency

3. State the reason bioenergy based energy carriers are considered sustainable.
 - A. Combustion efficiency is maximized only
 - B. Biomass resources are non-renewable
 - C. Biomass is managed to maintain carbon balance
 - D. Carbon release exceeds carbon uptake

4. Define Net carbon.
 - A. All carbon emissions are eliminated
 - B. Carbon emissions are balanced by carbon offsets or absorption
 - C. Carbon emissions exceed carbon removal
 - D. Fossil fuels are completely replaced

5. Identify the main characteristic of run-of-river hydroelectric plants.
 - A. Minimal water storage and dependence on river flow
 - B. Large water storage reservoirs
 - C. Operation using pumped storage systems
 - D. High greenhouse gas emissions

6. State the effect of a higher hydraulic head in a hydroelectric system.
 - A. Increased water evaporation losses
 - B. Increased potential power generation
 - C. Reduced turbine efficiency
 - D. Lower power output

7. Identify the characteristics of grid-connected solar PV systems
 - A. Mandatory battery storage for operation
 - B. Electrical isolation from the utility grid
 - C. Exporting excess electricity to the utility grid
 - D. Operation without an inverter

8. Describe the role of carbon capture, utilisation and storage (CCUS) in achieving net zero.
 - A. Increase fossil fuel consumption
 - B. Eliminate energy carriers
 - C. Capture and store emitted carbon dioxide
 - D. Replace renewable energy technologies

9. Choose the main component responsible for converting water energy into electrical energy in a hydroelectric plant.
 - A. Penstock
 - B. Transformer
 - C. Turbine
 - D. Generator

10. Identify the type of energy that is converted in solar photovoltaic power generation.
 - A. Light energy into electrical energy
 - B. Nuclear energy into electrical energy
 - C. Light energy into electrical energy
 - D. Thermal energy into mechanical energy

11. State the most suitable feedstock for biogas production through anaerobic digestion.
 - A. Plastic waste
 - B. Food waste and animal manure
 - C. Glass and metals
 - D. Dry Coal

12. Determine the primary function of an inverter in a solar PV system.
 - A. Reduce panel temperature
 - B. Convert DC electricity to AC electricity
 - C. Increase solar radiation intensity
 - D. Store electrical energy

13. State the reason hydroelectric energy is considered sustainable.
 - A. Provides clean power with storage
 - B. Causes acid rain
 - C. Depends on oil prices
 - D. Requires diesel backup

14. Choose the principle of wave energy conversion.
 - A. Kaplan turbine
 - B. Rooftop solar panels
 - C. Archimedes screw turbine
 - D. Oscillating water column system

15. State the bioenergy conversion process involving high-temperature reactions under limited oxygen to produce syngas.
 - A. Transesterification
 - B. Anaerobic digestion
 - C. Gasification
 - D. Fermentation

16. Identify the renewable source that utilizes ocean energy.
 - A. Wind energy
 - B. Solar energy
 - C. Wave energy
 - D. Tidal energy

17. State the main reason that makes tidal energy known as 'more predictable' as compared to wind and solar energy.
 - A. Ocean salinity variations
 - B. Seasonal weather patterns
 - C. Astronomical cycles
 - D. Random ocean turbulence

18. State the principle of electricity generation by tidal stream energy.
 - A. Wave crest motion
 - B. Oscillating water columns
 - C. Kinetic energy of moving tidal currents
 - D. Thermal gradients in seawater

19. Determine the main effect of higher tidal range at a site.
 - A. Reduced turbine efficiency.
 - B. Increased potential energy available for generation.
 - C. Increased corrosion of marine structures.
 - D. Lower potential power output.

20. State the primary factor that caused tidal range.
 - A. Difference in water level between high tide and low tide
 - B. Horizontal distance traveled by tidal currents
 - C. Average depth of seawater at a coastal site
 - D. Duration of one tidal cycle

21. Determine the performance ratio (PR) of a solar PV system.
- A. The fraction of solar radiation reflected by panels.
 - B. The ratio of installed capacity to land area.
 - C. Overall system efficiency considering real losses.
 - D. Battery storage capacity of the system.
22. State the impact of a rise in solar cell temperature on its efficiency.
- A. Lower voltage and reduced efficiency
 - B. Higher voltage and higher efficiency
 - C. Higher current with constant efficiency
 - D. No effect on electrical performance
23. Identify the primary function of pump storage in a hydroelectric plant.
- A. Treat water for domestic use
 - B. Store electrical energy using water elevation
 - C. Generate base-load power continuously
 - D. Reduce sedimentation in rivers
24. Determine the energy power conversion in hydroelectric power generation.
- A. Chemical energy into mechanical energy
 - B. Thermal energy into electrical energy
 - C. Potential energy of stored water into electrical energy
 - D. Solar radiation into electrical energy

25. State the main combustible component of biogas.
- A. Methane (CH_4)
 - B. Nitrogen (N_2)
 - C. Hydrogen sulfide (H_2S)
 - D. Carbon dioxide (CO_2)
26. Indicate the principal reason for defining hydrogen produced using renewable electricity as an energy carrier.
- A. Replaces biomass resources
 - B. Exists naturally in usable form
 - C. Stores chemical energy for later use
 - D. Emits carbon dioxide during storage
27. Identify the function of an energy carrier.
- A. Generate primary energy from natural resources
 - B. Eliminate energy conversion losses
 - C. Store and transport energy from the source to end users
 - D. Increase fossil fuel reserves
28. Choose the scenario in which bioenergy supports Malaysia's net carbon strategy.
- A. Biomass resources are over exploited
 - B. Combustion efficiency is ignored
 - C. Sustainable biomass management maintains carbon balance
 - D. Carbon emissions exceed carbon uptake

29. State the reason bioenergy is considered sustainable.
- A. Derived from renewable biological sources
 - B. Independent of land use
 - C. Higher in energy density
 - D. Free from emissions
30. Determine the electrical energy in kWh obtained from 36 MJ of biomass energy, assuming 100% conversion efficiency.
- A. 10kWh
 - B. 15kWh
 - C. 2kWh
 - D. 8kWh
31. Calculate the equivalent power in watts (W) for a solar panel rated at 1.5 kW.
- A. 150 W
 - B. 15,000 W
 - C. 150,000 W
 - D. 1,500 W
32. Determine the number of 300 W solar panels required to meet a total power demand of 3 kW.
- A. 12 panels
 - B. 10 panels
 - C. 8 panels
 - D. 5 panels

33. Determine the operational condition under which an ebb-generating system produces electricity
- A. During storm surge
 - B. During slack water
 - C. During incoming high tide
 - D. During outgoing low tide
34. State the principle behind tidal energy generation.
- A. Geothermal heat from the ocean floor
 - B. Wind stress acting on the sea surface
 - C. Solar radiation heating the ocean surface
 - D. Gravitational forces between the Earth, Moon, and Sun
35. Identify the tidal power technology that uses a dam constructed across an estuary.
- A. Tidal fence
 - B. Tidal lagoon
 - C. Tidal barrage
 - D. Tidal turbine
36. Identify the primary component responsible for converting mechanical rotation into electrical energy in a wind turbine.
- A. Yaw Drive
 - B. Generator
 - C. Anemometer
 - D. Gearbox

37. Choose the wind turbine size most suitable for powering a single all-electric home.
- A. Home-sized turbine with small rotor diameter
 - B. Utility-scale turbine (50–750 kW)
 - C. Large onshore commercial turbine
 - D. Offshore turbine (>5 MW)
38. Determine the function of the gearbox from the low-speed shaft in a wind turbine system.
- A. Gearbox increases rotational speed while the shaft transmits rotation
 - B. Gearbox controls wind direction while the shaft supports blades
 - C. Gearbox measures wind speed while the shaft generates electricity
 - D. Gearbox reduces torque while the shaft increases speed
39. Determine the design rationale for selecting hub heights between 60–100 m in most land-based wind turbines.
- A. To reduce installation cost
 - B. To simplify maintenance activities
 - C. To access higher and more stable wind speeds
 - D. To minimize blade length
40. Identify the impact of increasing rotor diameter on the power output of a wind turbine.
- A. Power fluctuates unpredictably
 - B. Power decreases due to higher drag
 - C. Power remains constant
 - D. Power increases due to larger swept area

SECTION B (Total: 60 marks)

Answer THREE (3) questions only.

Please use the answer booklet provided.

Question 1

According to Figure 1, the Hoover Dam lies across the Colorado River and holds back a huge reservoir of water producing a head of water for power production of 180 m. All of the river flow passes through the turbines. In a typical year 4.2×10^{12} Wh of electricity is produced.

Refer Below - Figure1 : Hoover Dam .

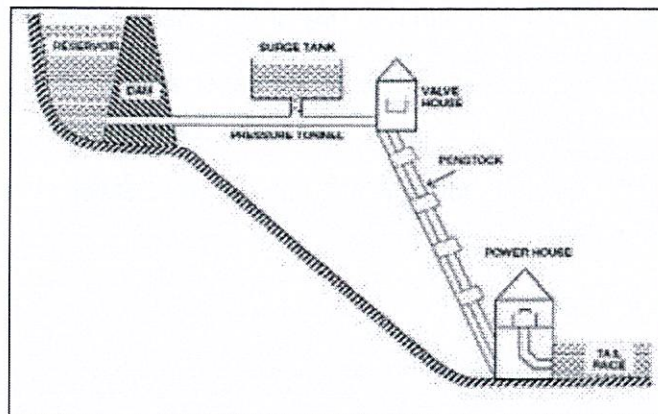


Figure 1: Hoover Dam

- (a) Describe the principles of generating electricity from hydro as the energy resource. (6 marks)
- (b) Calculate the corresponding average mass flow rate of water by assuming an overall efficiency of 85% for the turbine/generator. (10 marks)
- (c) When the river is running high a total of 1200 tonnes/second of water flows through the turbines. Measure the power generated in these conditions. (4 marks)

Question 2

A wind turbine located in Norway operates for 3 hours of continuous operation daily. As shown in figure below, the blade length is 10 meter and the efficiency is 40%.

Refer Below - Figure2 : Turbine blade .

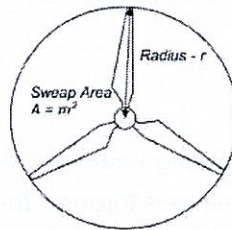


Figure 2: Turbine blade

- (a) Given the wind speed is 10 km/h and the air pressure and temperature are 101.325 kPa and 15°C, calculate the energy output of the wind turbine during the operation. Given the air density is 1.225 kg/m³.

(10 marks)

- (b) Describe five disadvantages of implementing wind energy in Norway.

(10 marks)

Question 3

Water flowing in River Thames whose channel is roughly rectangular with depth of 0.6m and width of 4m has water flow speed of 0.9 m/s.

- (a) Calculate the volume flow rate and mass flow rate of the water flowing.
(6 marks)
- (b) A weir on the river provides a working head of 1.5m for a turbine/generator. If one third of the river flow could be diverted through the turbine, measure the electrical power could be generated with 75% turbine's efficiency.
(8 marks)
- (c) Describe the concept of river diversion to harvest hydro power.
(6 marks)

Question 4

An urban area with a population of 1,000 people is experiencing a steady increase in electricity demand due to residential housing, small commercial activities, street lighting, and public facilities. The local authority plans to install a renewable energy system to support sustainable development and reduce dependence on fossil fuels. The area has limited open land, good solar exposure on rooftops, low and inconsistent wind speeds, and produces moderate organic waste from households.

- (a) Estimate the total daily electricity demand of the urban area, assuming an average consumption of 5 kWh per person per day.
(4 marks)
- (b) Explain two suitable renewable energy sources that can be implemented in this urban area.
(6 marks)
- (c) Analyse the suitability of the identified renewable energy sources by considering land availability, resource potential, environmental impact, and system scalability.
(6 marks)
- (d) Justify the most appropriate renewable energy option for this urban area with a population of 1,000.
(4 marks)

END OF EXAMINATION PAPER

Formula:

Hydroelectric Power is a Function of Height and Volume

$$P = \eta \rho Q g h$$

- P is power [W]
- η is the dimensionless efficiency of the turbine [approx. 0.9]
- ρ is the density of water [1,000 kg/m³]
- Q is the volumetric flow rate [m³/s]
- g is the acceleration due to gravity [9.8 m/s²]
- h is the height difference between inlet and outlet [m]

Wind Power $P_w = \frac{1}{2} \rho A v^3$

Density [kg/m³]
Small changes with elevation & temperature.

Area [m²]
Squared effect of changes in radius.

Velocity [m/s]
Cubic effect of changes in wind speed.

Conversion Table:

FACTORS FOR UNIT CONVERSIONS

Quantity	Equivalent Values
Mass	$1 \text{ kg} = 1000 \text{ g} = 0.001 \text{ metric ton} = 2.20462 \text{ lb}_m = 35.27392 \text{ oz}$ $1 \text{ lb}_m = 16 \text{ oz} = 5 \times 10^{-4} \text{ ton} = 453.593 \text{ g} = 0.453593 \text{ kg}$
Length	$1 \text{ m} = 100 \text{ cm} = 1000 \text{ mm} = 10^6 \text{ microns } (\mu\text{m}) = 10^{10} \text{ angstroms } (\text{\AA})$ $= 39.37 \text{ in.} = 3.2808 \text{ ft} = 1.0936 \text{ yd} = 0.0006214 \text{ mile}$ $1 \text{ ft} = 12 \text{ in.} = 1/3 \text{ yd} = 0.3048 \text{ m} = 30.48 \text{ cm}$
Volume	$1 \text{ m}^3 = 1000 \text{ L} = 10^6 \text{ cm}^3 = 10^6 \text{ mL}$ $= 35.3145 \text{ ft}^3 = 220.83 \text{ imperial gallons} = 264.17 \text{ gal}$ $= 1056.68 \text{ qt}$ $1 \text{ ft}^3 = 1728 \text{ in.}^3 = 7.4805 \text{ gal} = 0.028317 \text{ m}^3 = 28.317 \text{ L}$ $= 28,317 \text{ cm}^3$
Force	$1 \text{ N} = 1 \text{ kg} \cdot \text{m/s}^2 = 10^5 \text{ dynes} = 10^5 \text{ g} \cdot \text{cm/s}^2 = 0.22481 \text{ lb}_f$ $1 \text{ lb}_f = 32.174 \text{ lb}_m \cdot \text{ft/s}^2 = 4.4482 \text{ N} = 4.4482 \times 10^5 \text{ dynes}$
Pressure	$1 \text{ atm} = 1.01325 \times 10^5 \text{ N/m}^2 (\text{Pa}) = 101.325 \text{ kPa} = 1.01325 \text{ bar}$ $= 1.01325 \times 10^6 \text{ dynes/cm}^2$ $= 760 \text{ mm Hg at } 0^\circ\text{C (torr)} = 10.333 \text{ m H}_2\text{O at } 4^\circ\text{C}$ $= 14.696 \text{ lb}_f/\text{in.}^2 (\text{psi}) = 33.9 \text{ ft H}_2\text{O at } 4^\circ\text{C}$ $= 29.921 \text{ in. Hg at } 0^\circ\text{C}$
Energy	$1 \text{ J} = 1 \text{ N} \cdot \text{m} = 10^7 \text{ ergs} = 10^7 \text{ dyne} \cdot \text{cm}$ $= 2.778 \times 10^{-7} \text{ kW} \cdot \text{h} = 0.23901 \text{ cal}$ $= 0.7376 \text{ ft} \cdot \text{lb}_f = 9.486 \times 10^{-4} \text{ Btu}$
Power	$1 \text{ W} = 1 \text{ J/s} = 0.23901 \text{ cal/s} = 0.7376 \text{ ft} \cdot \text{lb}_f/\text{s} = 9.486 \times 10^{-4} \text{ Btu/s}$ $= 1.341 \times 10^{-3} \text{ hp}$

Example: The factor to convert grams to lb_m is $\left(\frac{2.20462 \text{ lb}_m}{1000 \text{ g}} \right)$.