Program: B. Sc. Eng. (ME/IPE)
Semester: 6th

Date: 24 February 2023 (Afternoon)
Time: 2:00 PM – 3:30 PM

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Mid Semester Examination
Course Code: ME 4659
Course Title: Conventional and Non-conventional Energy Resources

Summer Semester: AY 2021-22
Full Marks: 75
Time: 1 Hour 30 Minutes

There are **three** questions. Answer **all** of them. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets. Assume reasonable design data if necessary. Programmable calculators are not allowed.

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1 (a)	Define conventional energy and non-conventional energy resources with types. Make a comparison between conventional and non-conventional energy systems.	(10) (CO1) (PO1)
(b)	Define solar constant and extra-terrestrial radiation. Explain why extra-terrestrial radiation varies throughout the year?	(5) (CO1) (PO1)
(c)	Write short notes on wind energy, hydropower and bioenergy. If available in your country, which resource is more suitable for implementation from environmental and economical perspective? Explain why?	(10) (CO1/ CO4) (PO3/ PO7)
2 (a)	Describe the working principle of a pyranometer with neat sketches. Explain its application for measuring solar radiation.	(10) (CO2) (PO3)
(b)	Calculate solar altitude angle, solar azimuth angle, zenith angle, profile angle and time of sunrise for a 55° sloped surface facing 24° west of south at 16:15 solar time on March 21 at a latitude of 50°. Also find the time of sunrise and sunset on the surface.	(15) (CO1/ CO2) (PO2)
3 (a)	Explain how solar energy can be converted? Classify different types of collectors for solar energy conversion with their key features.	(7) (CO2) (PO1)
(b)	Describe the working principle of a solar flate plate thermal collector with neat sketch.	(10) (CO2) (PO1)
(c)	Explain the I-V characteristic curve of a solar cell with the effects of temperature and irradiance on it.	(8) (CO4) (PO2)

Formula Sheet

$$\delta = 23.45 \sin\left(360\frac{284+n}{365}\right)$$

$$\begin{aligned}\cos\theta = {} & \sin\delta\sin\phi\cos\beta - \sin\delta\cos\phi\sin\beta\cos\gamma \\ & + \cos\delta\cos\phi\cos\beta\cos\omega + \cos\delta\sin\phi\sin\beta\cos\gamma\cos\omega \\ & + \cos\delta\sin\beta\sin\gamma\sin\omega\end{aligned}$$

$$\cos\theta_z = \cos\phi\cos\delta\cos\omega + \sin\phi\sin\delta$$

$$\gamma_S = \text{sign}(\omega)\left|\cos^{-1}\left(\frac{\cos\theta_z\sin\phi - \sin\delta}{\sin\theta_z\cos\phi}\right)\right|$$

$$\cos\omega_s = -\frac{\sin\phi\sin\delta}{\cos\phi\cos\delta} = -\tan\phi\tan\delta$$

$$\tan\alpha_p = \frac{\tan\alpha_s}{\cos(\gamma_s - \gamma)}$$

$$H_o = \frac{24\times 3600 G_{sc}}{\pi}\left(1 + 0.033\cos\frac{360n}{365}\right) \times \left(\cos\phi\cos\delta\sin\omega_s + \frac{\pi\omega_s}{180}\sin\phi\sin\delta\right)$$

For $\omega_s \le 81.4^\circ$

$$\frac{H_d}{H} = \begin{cases} 1.0 - 0.2727K_T + 2.4495K_T^2 - 11.9514K_T^3 + 9.3879K_T^4 & \text{for } K_T < 0.715 \\ 0.143 & \text{for } K_T \ge 0.715 \end{cases}$$

and for $\omega_s > 81.4^\circ$

$$\frac{H_d}{H} = \begin{cases} 1.0 + 0.2832K_T - 2.5557K_T^2 + 0.8448K_T^3 & \text{for } K_T < 0.722 \\ 0.175 & \text{for } K_T \ge 0.722 \end{cases}$$