

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Mid Semester Examination
Course Code: MCE 6241
Course Title: Renewable Energy

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 are written in the brackets. Assume reasonable data if necessary. Programmable calculators are not allowed. Formula sheet is attached in the second page.

-
- 1 (a) Describe Renewable Energy resources. Distinguish between Renewable and Non-renewable energy systems with advantage and disadvantage. (8)
- (b) Explain why Renewable Energy is regarded as a clean energy source? Describe the key factors which is driving the world to shift towards Renewable based power generation. (7)
- (c) Write short notes on Wind Energy, Hydro Energy and Bio Energy. Discuss the prospect of these resources based on the geographic location of your home country, explaining from economic and environmental perspective. (10)
- 2 (a) Draw neat sketches and define the surface azimuth angle, angle of incidence, solar altitude angle, zenith angle and solar azimuth angle. Draw a relationship between these angles. (10)
- (b) Calculate solar altitude angle, solar azimuth angle, zenith angle, profile angle and time of sunrise for a 45° sloped surface facing 25° west of south at 16:00 solar time on March 26 at a latitude of 55° . Also find the time of sunrise and sunset on the surface. (15)
- 3 (a) Describe the basic methods for solar energy conversion. The efficiency of conversion and energy density of solar power is lower than conventional fuel- Explain why? (7)
- (b) Explain the Solar Photovoltaic (Solar PV) Systems in detail with their working principle, accessories, types and applications. (10)
- (c) Discuss about different types of solar cells. Consider installing a Solar PV system at your home for domestic use only, which type of PV cell you will choose and why? (8)

Formula Sheet

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

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

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

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

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

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

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

For $\omega_s \leq 81.4^\circ$

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

and for $\omega_s > 81.4^\circ$

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