Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

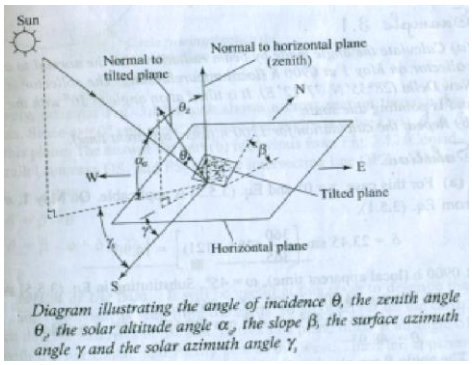
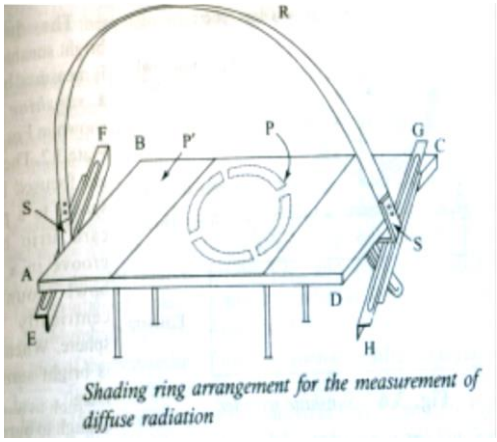
(A constituent unit of MAHE, Manipal)

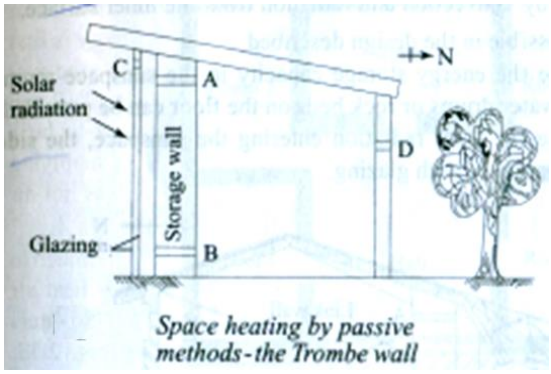
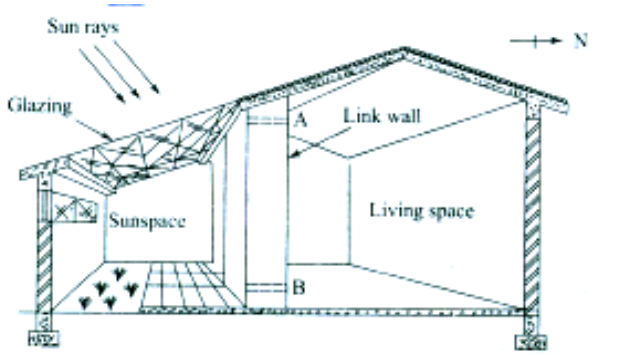
V SEMESTER B. TECH (MECHANICAL ENGINEERING) END SEMESTER EXAMINATIONS, NOVEMBER - 2019

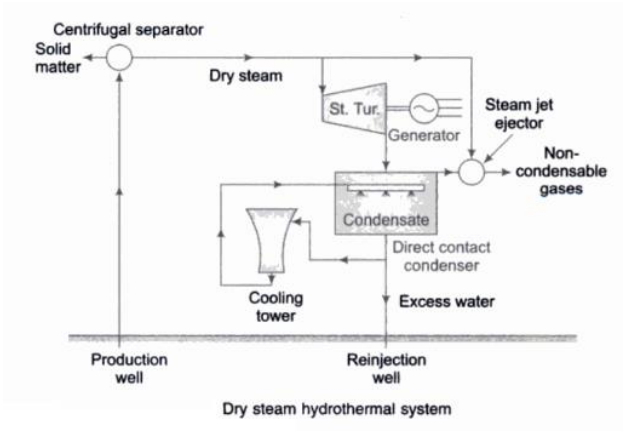
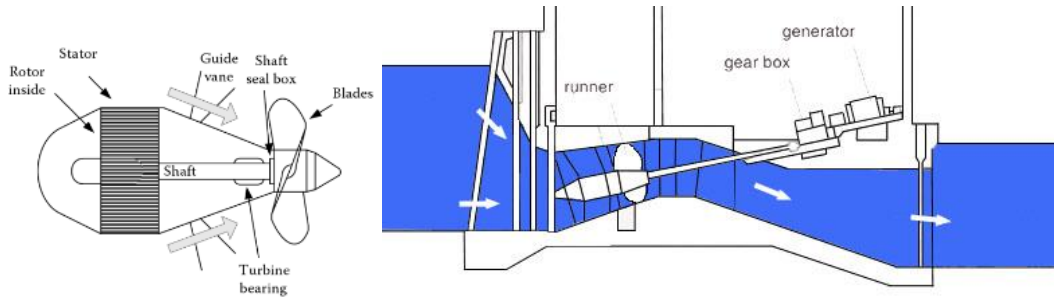
Subject: Non-Conventional Energy Sources [MME 4025]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

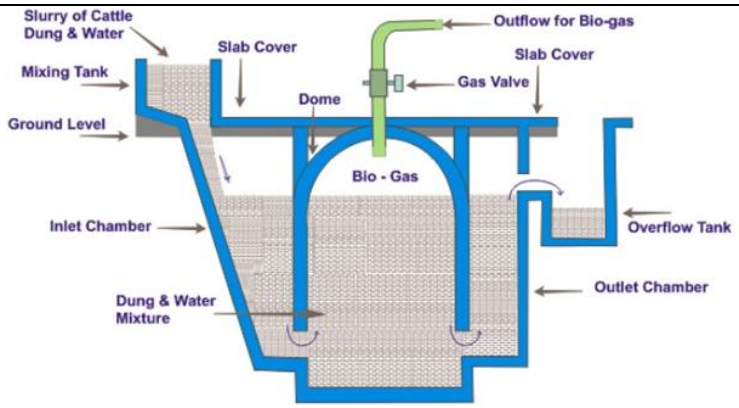
1A.	With neat sketch of solar earth geometry, explain the various angles required for solar radiation measurement.  *Diagram illustrating the angle of incidence θ, the zenith angle θ_z, the solar altitude angle α_s, the slope β, the surface azimuth angle γ and the solar azimuth angle γ_s* ***Sketch : 1.5 Mark ; Definition : 1.5 Marks***	**3**
1B.	With a neat sketch explain the instrument which measures the diffuse solar radiation.  *Shading ring arrangement for the measurement of diffuse radiation* The Pyranometer can also be used for measurement of diffuse radiation. This is done by mounting it at the centre of a semicircular shading ring. The shading ring is fixed in such a way that its plane is parallel to the plane of the path of the sun's daily movements across the sky and it shades the thermopile element and the two glass domes of the Pyranometer at all times from direct sunshine. Consequently, the Pyranometer measures only the diffuse radiation received from the sky. **Sketch :1.5 Marks ; Explanation 1.5 marks**	**3**
1C.	Calculate monthly average hourly global and hourly diffuse radiation during the month of September on horizontal surface at Udupi (13.3409° N, 74°.45' E) with the given data. Time 9:30 PM to 10:30 PM (Standard time).	**4**

	The average number of sunshine hour per day is 10 a = 0.27, b=0.43 for Monthly average daily solar radiation Klein's recommendation for the month of September is 15. For Monthly average hourly radiation a = 0.409+0.5016 sin (Ø̈s - 60) b = 0.6609-0.4767 sin (Ø̈s - 60) Delta = 2.2160	
2A.	Define w.r.t to liquid flat plate collector i) Heat removal factor ii) Collector efficiency factor iii) Transmissivity-Absorptivity product. **Plate effectiveness (ϕ):** is defined as the ratio of the heat conducted through the plate to the fluid tube, to the heat which would have been conducted if the thermal conductivity of the plate material was infinite. A higher value of ϕ means higher rate of heat transfer to the flowing fluid from the absorber plate. **Collector efficiency factor F'** : is the ratio of heat transfer resistance from fluid to ambient air to the heat transfer resistance from plate to ambient air and is a constant for any collector design and fluid flow rate. **Collector heat removal factor F_R** : it represents the ratio of actual useful heat gain rate to the gain which would occur if the collector was at the temperature of fluid at inlet everywhere. It is a measure of thermal resistance encountered by absorbed radiation in reaching collector fluid.	**3**
2B.	With a neat sketch explain the solar space heating application.  *Space heating by passive methods-the Trombe wall*  *Schematic diagram of a sunspace for passive space heating* Passive design approach for space heating is to construct a sunspace or greenhouse next to the living space to be heated. The sunspace is located on the south side of the building. It has a large glass roof and there is a thick wall with vents at the top and bottom linking it with the living space. Thus the sunspace acts as a buffer zone between the living space and the outdoor conditions. During the day, the sunspace gets heated up and warm air enters the living space through the top opening A. Cooler air from the living space is pulled out through the bottom opening B thereby establishing a natural circulation flow. In addition, energy is stored in the link wall. During the night, the openings are closed and the energy stored in the link wall is conducted through it and transferred to the living space by convection and radiation from the inner surface. **Sketch :1.5 Marks ; Explanation 1.5 marks**	**3**
2C.	In Bangalore (12.9716° N, 77.5946° E) a 2 m^2 solar flat plate collector is used to heat water. The collector is	**4**

	installed facing due south and inclined at 40^0 to the horizontal surface on May-15. This collector is tested for its instantaneous efficiency at 10:25 AM [Standard time] (equation of time correction -5 min). The flow rate through the collector was maintained at 70 kg/hr-m^2. The inlet water temperature is 35^0 C. While ambient temperature is 30^0 C. At the same time pyranometer without shading ring give the reading of 900 W/m^2 and with shading ring gave 150 W/m^2. Neglect the reflected radiation from the surface. Calculate the (a)Total radiation (b)Efficiency of the collector (c) Collector temperature (d) Solar altitude angle. Assume Cp = 4.2 KJ/kg K ; $\tau\alpha$ =0.84 ; FR= 0.822 ; U_L = 5.5 W/m^2-K.	
3A.	Prove that only 59.2 % of available wind power can be extracted from a horizontal axis wind turbine.	**3**
3B.	With neat sketch explain the working of Vapor dominated (dry steam) geothermal system.  Dry steam hydrothermal system **Sketch :1.5 Marks ; Explanation 1.5 marks**	**3**
3C.	What are the challenges to construct the small-scale hydro-electric power plant? Explain any one of the Turbine for small scale hydroelectric plant.  With the bulb-turbine arrangement (Figure above) the generating set is contained in a capsule accommodated in the water passageway. It is a very compact and self-contained unit. There can, however, be problems with cooling the generator and access to the generator itself, although for small units the generator can be removed in its entirety for maintenance. For reasons of economy the generator must be of small diameter and therefore low inertia, thus limiting the application of bulb sets to connection with electrical systems of adequate size to maintain electrical stability. The bulb turbine is suitable for a head range of about 5-20 m and ratings of 300kW. During its operation, water flows around the turbine, passing the generator, guide vanes, blades, and draft tube into tail channel. It has normally three to five blades made of stainless steel.	**4**

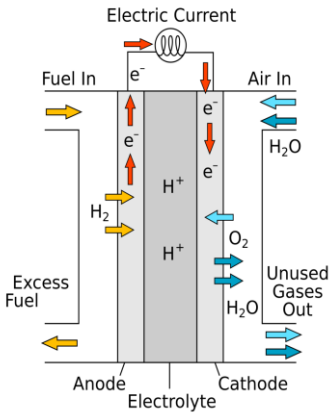
	Challenges :1 Marks ; Explanation of one of the turbine 3 marks	
4A.	It is desired to set up a power plant to covert the ocean tidal energy into electricity. The plant should consist of single basin and generates power only during high tides. Derive the expression for power output for the proposed power plant in terms of range of the tide.	**3**
4B.	Ocean waves on an Indian coast had an amplitude of 1.2 m with a period of 6 seconds measured at the surface of the water 110 m deep. Taking water density as 1025 kg/m^3, calculate the following (a) Wave velocity (b) Energy density (c) Power density of the wave.	**3**
4C.	A thermoelectric generator operates between the temperature limits of 1200 K and 500 K. The cross-sectional areas and lengths of n and p type elements are: A_1= 2.5 cm^2, l_1= 1.0 cm and A_2= 2.0 cm^2, l_2= 2 cm, respectively. Calculate the (a) Optimum figure of merit (b)Optimum efficiency (c) Efficiency for maximum power output (d) Carnot efficiency. The following properties may be used.	**4**
5A.	With neat sketch explain the Fixed dome type biogas plant.	**3**

Properties	**n-type**	**p-type**
See back coefficient (α_s) volt/°C	$-180x10^{-6}$	$180x10^{-6}$
Specific resistivity (ρ) ohm-cm	$1.45x10^{-3}$	$1.8x10^{-3}$
Figure of merit (z) K^{-1}	$2x10^{-3}$	$1.7x10^{-3}$



Sketch :1.5 Marks ; Explanation 1.5 marks

5B. With neat sketch explain the working of a suitable energy conversion device that makes use of hydrogen as fuel with byproduct as water.



Sketch :1.5 Marks ; Explanation 1.5 marks **3**

5C. Write a note on (a) MHD generator (b)Energy plantation

A **magnetohydrodynamic generator** (**MHD generator**) is a magnetohydrodynamic converter that utilizes a Brayton cycle to transform thermal energy and kinetic energy directly into electricity. MHD generators are different from traditional electric generators in that they operate without moving parts (e.g. no turbine) to limit the upper temperature. They therefore have the highest known theoretical thermodynamic efficiency of any electrical generation method. MHD has been extensively developed as a topping cycle to increase the efficiency of electric generation, especially when burning coal or natural gas. The hot exhaust gas from an MHD generator can heat the boilers of a steam power plant, increasing overall efficiency.An MHD generator, like a conventional generator, relies on moving a conductor through a magnetic field to generate electric current. The MHD generator uses hot conductive ionized gas (a plasma) as the moving conductor. The mechanical dynamo, in contrast, uses the motion of mechanical devices to accomplish this.

Energy plantation is the practice of planting trees, purely for their use as fuel. Terrestrial biomass *i.e.*, the wood plants has been used since long time to generate fire for cooking and other purposes. In recent years, to meet the demand of energy, plantation of energy plants has been re-emphasized. It is well known fact that trees have been intensively cut in Gangetic plains and coastal belts, leaving the area totally denude. The same practice has also been **4**

	done in Shfwalik region and foot-hills of Himalayas. According to a report, if fuel/fire wood plants were not raised rapidly, by 2,000 AD more than 250 millions people would not be able to manage fuels for cooking purpose and, therefore, they would be forced to burn animal dung which, however, depends on availability of animals and agricultural crop residues (Anonymous, 1980 c). **2 Marks each (a) and (b)**	