Name:

Enrolment No:

UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

END-TERM Examination, DEC. 2019

Programme Name: B.TECH: **ASE, ASE+AVE, ECE, ELE, APE-GAS, CERP, FSE, ADE, ME**

Semester: V

Course Name : ASTRONOMY AND ASTROPHYSICS — Time : 03 hrs

Course Code : PHYS3102 — Max. Marks: 100

Nos. of page(s) : 5

Values of some physical constants:

Planck's constant, $h = 6.6 \times 10^{-34}\, Js$, Velocity of light, $c = 3 \times 10^{8} ms^{-1}$,

Gravitational Constant, G = 6.67 x 10^{-11} m^3 $Kg^{-1}S^{-2}$ Boltzmann constant, $\boldsymbol{k_B = 1.38 \times 10^{-23}} m^2Kgs^2K^{-1}$

Electronic charge (e) = 1.6 × 10^{-19} C, Wien's constant = 2.898 x 10^{-3} m-K Stefan's constant, σ = 5.67 x 10^{-8} $W/m^2/K$

SECTION A

S. No.		Marks	Cos
Q 1	Compute the mass of the Sun if orbital period of the Earth is 3.16 x 10^7 sec and average distance between earth and sun is 1.5 x 10^{11} m.	5	CO4
Q.2	Describe briefly how the reddening of the stars is taking place.	5	CO2
Q.3	Define the Earth's Magneto-sphere. Discuss how it is protecting Earth from solar wind	5	CO3
Q.4	Describe the two techniques to measure the mass of galaxies.	5	CO4

SECTION B

Q.5	Define the Coriolis force. If Coriolis force is given by $F = 2\Omega \sin\ (\Phi) v$ in units m/s^2 where $\Omega = 7.27 \text{x} 10^{-5} s^{-1}$ is the earth's rate of rotation. Φ denotes the latitude and v is speed in m/sec relative to Earth of the object in question. Calculate the magnitude of the Coriolis force acting on the body moving with speed 50 m/s in Northern hemisphere. What will be the direction of Coriolis force acting on the body?	10	CO2
Q.6	(a) A star has an apparent magnitude of 6.0 and 9.0 as minimum and maximum, respectively. Its minimum and maximum effective temperature is 2600K and 1900K. Find the ratio of maximum and minimum radii? (b) Knowing that the apparent magnitude of the Sun is − 26.73, calculate its absolute magnitude.	5 5	CO4

Q.7	If we have a star that is at 100 parsecs and if its apparent brightness is 12, then what would have to be its distance in order to be seen with an apparent brightness of 9? Give the distance in parsecs, AU and in light years. **OR** Plot the variation of the day length on a horizontal surface through the year for the place New Delhi (280 35' N, 770 12' E). Day length may be calculated on average day of the month.	10	CO4
Q.8	(a) What is Hubble's Law and how is it used by astronomers to measure distances to galaxies? (b) According to the Hubble's law, with $H_0 = 70$ Km/sec/pc, what is the recessional speed of a galaxy at a distance of 200 MPc?	5 5	CO2
	SECTION-C **Q.9 is compulsory. Attempt any one out of Q.10 and Q.11**		
Q.9	Write the short notes on the following: (a) Nebula and types of Nebula (b) Black Holes and their properties (c) Big Bang expansion (d) Milky Way Galaxy and Orion arm	20	CO1
Q.10	(a) Write the 10 major effects of space weather on Earth. (b) The NASA, Mars Radiation Environment Experiment (MARIE) measured the daily radiation dosages from a satellite orbiting Mars between March 13, 2002 and September 30, 2003 as shown in the figure given in appendix-II. The dose rate is given in units of milliRads per day. (1 Rad = 2 Rems for cosmic radiation). The six tall 'spikes' are Solar Proton Events (SPEs) which are related to solar flares, while the rest of the plotted data is the dosage caused by galactic cosmic rays (GCRs). (i) By finding the approximate area under the plotted data, calculate the total radiation dosage in Rems for the GCRs during the observation period between 4/03/2002 and 8/20/2003. (ii) Assuming that each SPE event lasted 3 days, and that its plotted profile is a simple rectangle, calculate the total radiation dosage in Rems for the SPEs during the observation period. (iii) What would be the total radiation dosage for an unshielded astronaut orbiting Mars under these conditions? (iv) Are SPEs more important than GCRs as a source of radiation?	10 10	CO3

Q.11	(a) Define the different units for the measurement of ionizing radiations. What is the difference between Sievert and Gray? (b) Spacecraft engineers design space craft by considering the radiation environment to shield the astronauts from harmful ionizing space radiations. For designing purpose, they used the following model for the orbit path as a function of angular position, $R(\theta)$ and radiation dose rates, $G(R)$. $$\frac{R(\theta)}{R_0} = 5.7 - \left[\frac{210}{100 - 55\cos\theta}\right]$$ where R_0 is the earth radius equal to the 6378 Km $$T(\theta) = \frac{9}{2\pi}(\theta - 0.55\sin\theta) \text{ hours}$$ $$G(R) = 0.136R^6 - 2.194R^5 + 13.89R^4 - \frac{43}{73}R^3 + 71.78R^2 - 57.95R + 18.15 \text{ Grays/hours}$$ (i) Construct the function table where the columns are θ, $T(\theta)$ in hrs, $R(\theta)$ in multiple of R_0 and $G(\theta)$ in Grays/hrs. (ii) Plot the graph $G(T)$ in (Grays/hrs) Vs T (in hrs) over one complete orbit over the domain T [0, 9hrs]. (iii) Estimate the geometric area under the curve and then calculate the total accumulated dose over the one complete orbit. (iv) If 1 cm thickness of aluminum reduce the radiation by 15 times, then how many cm of shielding will be needed to reduce the total accumulated dose to 1000 Grays over 5 years.?	5 5 5 2 3	CO3

Appendix-I

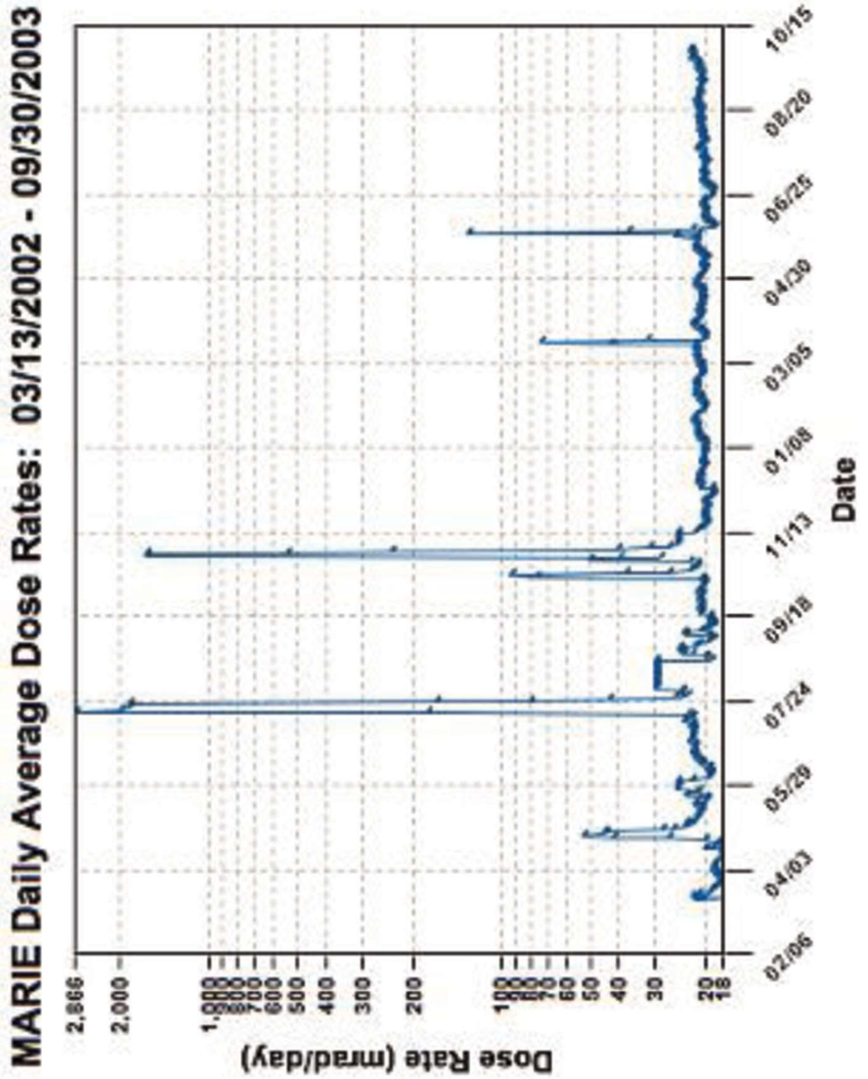
Table: Recommended Average Days for Months and Values of n by Months

Month	n for ith Day of Month	For Average Day of Month	
		Date	n
January	i	17	17
February	$31+i$	16	47
March	$59+i$	16	75
April	$90+i$	15	105
May	$120+i$	15	135
June	$151+i$	11	162
July	$181+i$	17	198
August	$212+i$	16	228
September	$243+i$	15	258
October	$273+i$	15	288
November	$304+i$	14	318
December	$334+i$	10	344

Useful Models and Equations

1. Declination $\delta = 23.45 \sin\left[\frac{360}{365}(284+n)\right]$ n: day number
2. Sun set/sun rise hour angle
   $\omega_s = \cos^{-1}(-\tan\emptyset\tan\delta)$ where $\emptyset$ is the latitude.
3. Day Length
   $$N = \frac{2}{15}\omega_s$$
4. $E_0 = \left(\frac{r_0}{r}\right)^2 = 1 + 0.033\cos\left[\frac{2\pi n}{365}\right]$; where n is the day number and r_0 is the average distance between earth and sun and equal to the 1.5 x 10^{11} m.
5. Solar time (AST) = local standard time $\pm\ 4(L_S - L_C) + Et$ where L_S is the standard longitude and L_C is the local longitude.
   $$E_t = (0.000075 + 0.001868\cos\Gamma - 0.032077\sin\Gamma - 0.014615\cos 2\Gamma - 0.04089\sin 2\Gamma)(229.18).$$
   where $\Gamma = 2\pi(n-1)/365$

Appendix-II


MARIE Daily Average Dose Rates: 03/13/2002 - 09/30/2003
Dose Rate (mrad/day)
2,866
2,000
1,000
600
500
400
300
200
100
70
60
50
40
30
20
18
Date
02/06
04/03
05/29
07/24
09/18
11/13
01/08
03/05
04/30
06/25
08/20
10/15