ELEC-E4210 Introduction to Space (5 cr)
Exam 8.4.2016

Answer all five questions. Always justify your answers. However, there is no need to write a book, the facts count!

1. On March 21st, you are making radio observations in Metsähovi (Latitude: N 60° 13' 4.1", Longitude: E 24° 23' 35.2") as part of the AGN team's monitoring programme. You are observing through the night, and your observing shift ends at 9 o'clock in the morning, local time. At 6 o'clock, local time, a colleague of yours from a foreign institute calls you and asks if you can make observations of the two sources listed in Table 1. If we assume that no overhead time will be needed to prepare the observations, and one observing run for each source takes about half an hour effective time, can you observe them during the remaining time of your shift? (6p)

Table 1:

Nro	Source	RA	DEC
1.	PKS0537–441	05h 38m 50.362s	–44° 05' 08.939"
2.	PKS2032+107	20h 35m 22.300s	+10° 56' 06.000"

2. Consider a 2500 kg communication satellite at Molniya orbit with apogee at 40 000 km and perigee at 800 km altitude. The inclination of the orbit is 63.4 degrees.
a) Calculate the orbital period of the satellite in hours at this Molniya orbit. (2p)
b) Calculate the single delta V kick which would bring the satellite to a circular LEO orbit. (3p)
c) Where and in which direction this speed kick should be given? (1p)

3. An interstellar gas cloud is being heated by a new star forming nearby. The temperature of the cloud to increases from 70 K to 120 K. (Justify all answers.)

a) At what frequency does the blackbody spectrum peak before and after the heating? (1p)
b) What happens to the blackbody brightness observed at low radio frequencies? (2p)
c) What happens to the total energy radiated by the cloud? (2p)
d) What happens to the location (frequency) of the emission lines? (1p)

4. Explain briefly the following concepts (with one or two sentences only, no need to write a book).
a) Magnitude (2p)
b) Pulsar (2p)
c) SgrA* (2p)

MORE QUESTIONS ON THE SECOND PAGE!

5. You are observing an exoplanet OXY-2 and measured that near the planet the magnetic field associated with the undisturbed stellar wind was the following: The radial magnetic field was 50 nT (that is B_r = 50 nT) and the magnetic field component perpendicular to the radial component was 100 nT (that is B_phi = 100 nT). The distance from the exoplanet OXY-2 from the centre of its sun is 1000 R, where R (=10^6 km) is the radius of the sun of the exoplanet. The sun is known to produce purely radially outward flowing stellar wind which has an infinite large electrical conductivity.

Your colleague is investigating another exoplanet OXY-1 of the same sun which is 10 R from the centre of the sun. Unfortunately, her magnetometer and space plasma instrument is broken and she needs your help.

a) What would be your estimation for the value of the B_r and the B_phi at OXY-1? You both are on the ecliptic (xy) plane and the rotation axis of the sun is along the z-axis. Justify your equations. (3p)
b) Your colleague would like know what is the rotation speed of the sun, i.e. what is the angular velocity, w [rad/s], of the sun. You have a plasma instrument on board and it detected undisturbed stellar wind with the speed of 1000 km/s. What would be your estimation for the angular velocity (w) of the sun? Justify your equations. (3p)