UNIVERSITY OF CAPE TOWN
EXAMINATION ANSWER BOOK

FOLD (Fold over on dotted line and seal with stickers supplied.)

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Student No. CHTISA006

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All answer books must be numbered

Number of books handed in	
Number of this book	

Date 09/06/2023

Degree/Diploma/Certificate for which you are registered (e.g. BA BSc)

Course code and description (to be copied from the heading on the Examination Paper)

Paper No (to be copied from the heading on the Examination Paper)

Venue:

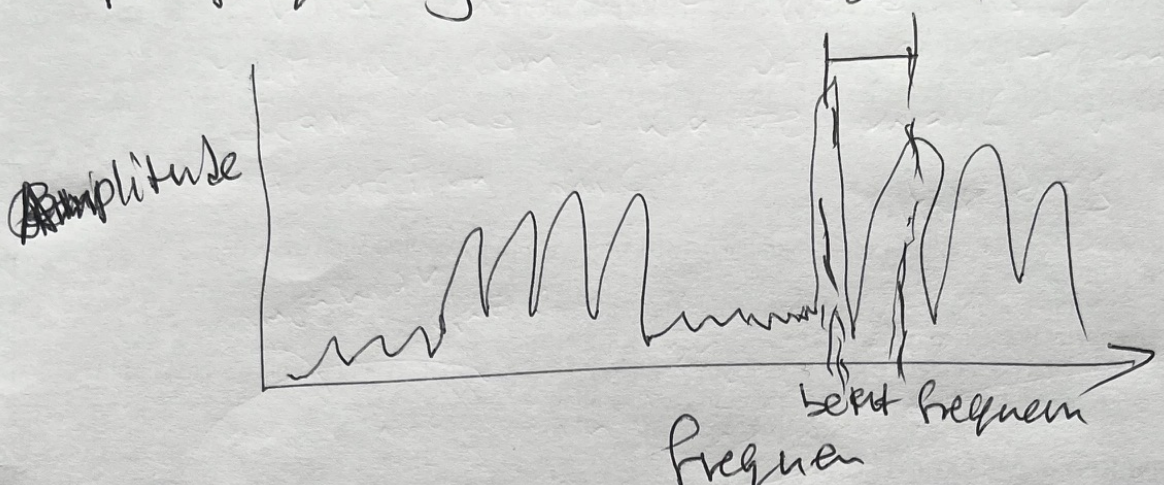
EVERY CANDIDATE MUST enter below the book number and the number of each question answered (in the order in which it has been answered); leave columns (3) and (4) blank.

1	2	3	4
Book Number	Question Number	Internal	External
	2	7	
	4	7	
	5	10	
		24	
Examiner's Initials		SBP	

STUDENTS ARE TO READ THE IMPORTANT NOTES AND WARNINGS ON THE BACK COVER.

Any dishonesty will render the candidate liable to disqualification and to disciplinary action.

Fourier transform is a mathematical technique that changes time domain light curves to frequency domain.



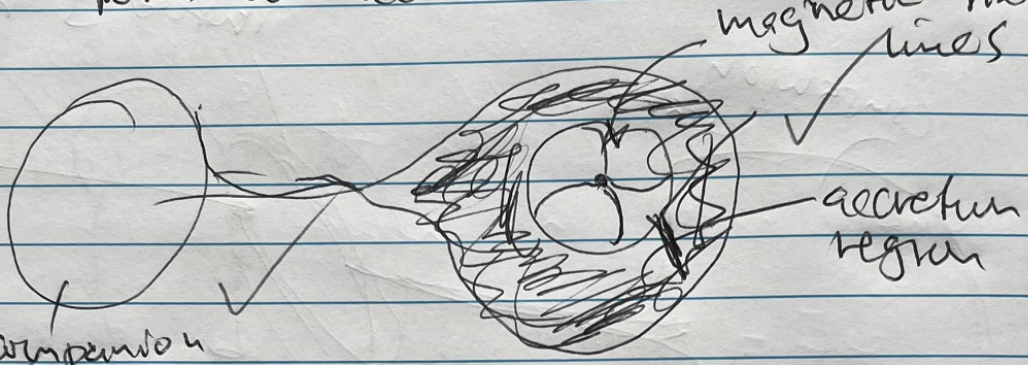
From the light curve the beat period and frequency can be derived

$$\text{beat period} = \left| \frac{1}{f_b} - \frac{1}{f_{period}} \right| ?_0$$

3 Intermediat Polar

→ Are CVs that have magnitude of magnetic field ~~1MG < B < 10MG~~ 1MG < B < 10MG.

- due to weaker magnetic fields they form an accretion.



The ~~field~~ point is the region with magnetic field lines only up to white dwarf

The spin period < orbital period.

In intermediate polar there exist the change in flow of the materials as ~~it~~ it enter in the WD region. The WD changes the pole for short ~~bet~~ period of time which results into beat period modulation.

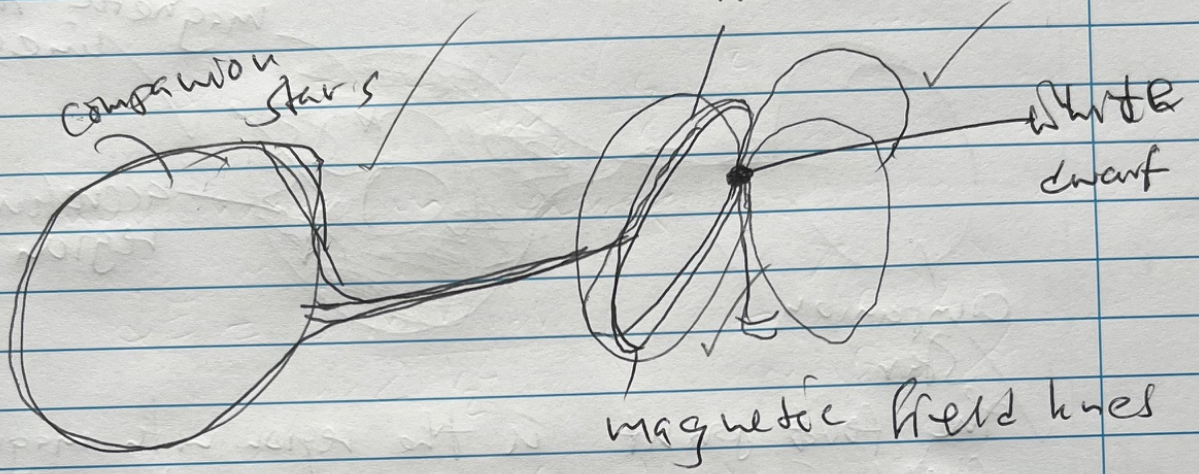
In the light curve ~~a~~ period can be seen depending on how ~~the~~ light curve behaves but there will be an out burst within the period which will make us calculate the beat period.

(10) $\text{beat period} = \frac{1}{f_2} - \frac{1}{f_{\text{period}}}$.

5 Polar (AM Her Star)

AM Her Star

- It a polar cataclysmic variable with magnetic field $B > 10MG$
- It is comprise of a companion star and a white dwarf without accretion disc.

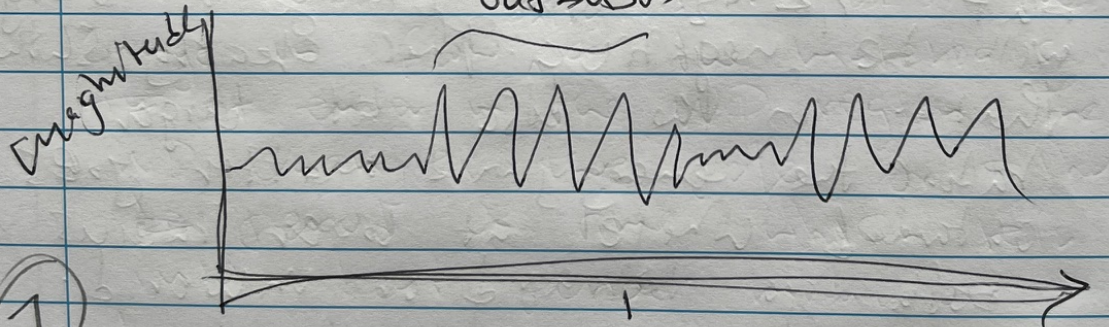


- Since the magnetic field is too strong the materials ~~in the~~ as they transfer from companion star to the white dwarf through the threading region, the material move along the with the field lines hence no accretion.
- As the material are ~~a~~ corotating with the field lines the particles are in a helical or spiral motion this results in to cyclotron ~~em~~ emission.
- There can also be free-free electron emission (Bramstrung emission)
- Their spin period = ~~orbit~~ orbital period.

7

a quiescent state while if there is an ~~term~~ increase in the mass flow rate, it would mean more viscous occurring in the disc and then the system would be in an outburst state hence if a system exhibit such scenarios by changing the state ~~it is~~ it is called 'nova like' cataclysmic ✓

2 Z cam stars are of such state where there are in a nature of ~~pattern~~ exhibiting these two cases where their light curves can show a period of outbursts then quiescents ✓



(1)

4b Using momentum equation

$$J = \sqrt{GM\left(m_1 h_1^2 + m_2 h_2^2\right)}$$

differentiating with respect to h_2 and equating it to zero at maximum momentum we get

$$dh_2 = -\frac{m_1}{m_2}\left(\frac{r_2}{r_1}\right)^{h_2}$$

and change in energy

$$dE = \frac{GMm_1 dh_1}{2h_2^2}\left(1 - \left(\frac{h_1}{r_2}\right)^{3/2}\right)$$ X

Using the equation if $r_2 > r_1$ the change in energy will be ~~of positive~~ but $r_1 \geq r_2$ the change in energy will be negative. This clearly shows that in the disc at larger radius the energy and matter goes outward while at lower radius both go toward or inward. X

c Nature and origin of Z can stars and nova like cataclysmic.
In a scenario where there is low mass flow rate from secondary star to a white dwarf, this would lead to less viscous and low temperature hence the system remain

4(a) Disc instability model

- Viscosity is the resistence to flow of the material
- In the accretion disc the outer annulus accretes more as compared to the inner annulus hence an occurency called viscosity.

⇒ As the material is flowing in to the accretion disc through a hot spot, the density of matter increased which increases the viscosity this als results into increase in temperature.

⇒ As the temperature increases the ionisation of Hydrogen starts and increases causing the system to be more luminous at the same time als causing the opacity to increase which absorbs the heat produced from the viscosity. Hence thermal instability.

Since there is increase in temperature through viscosity and ionisation then a dwarf nova outburst can be observed.

Another instability is caused due to magnetic turbulence where cloud of matter interacting with other accreting matter increases magnetic field.

4b

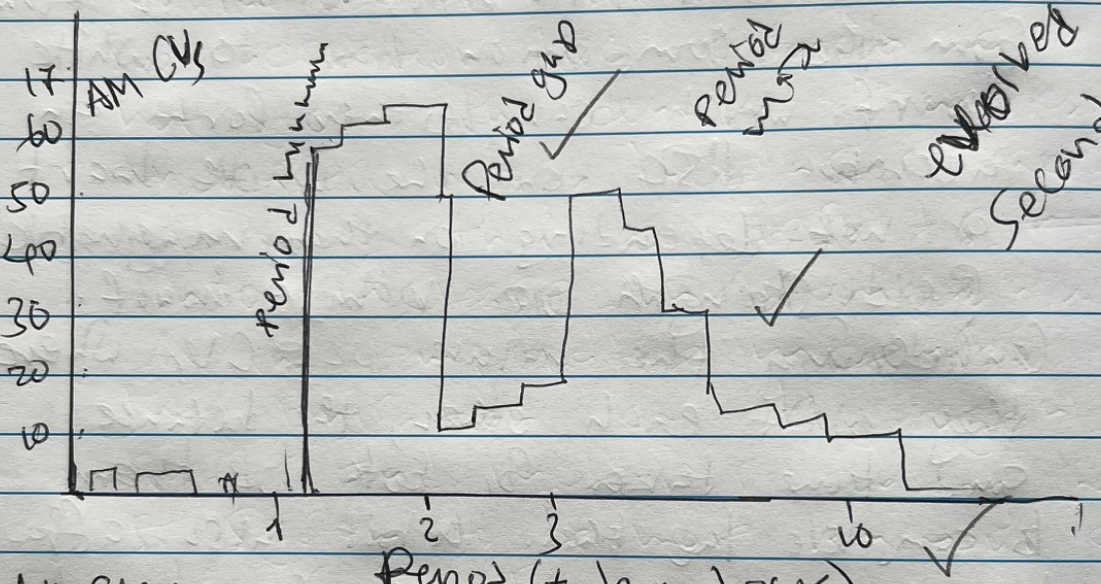
high loss of mass and momentum. Thus causes it to degenerate and be far from the MD resulting to less number of systems in this region

Using the bounce back model the secondary starts the process again of mass transfer hence the increase in number of systems after Porb > 3. Note that Porb > 3 the systems is controlled by magnetic braking.

(6)

(1) Magnetic braking
This is where the ionised electric charged are discharged from the companion star

(3) Period orbital distribution



AM CVs
the companion has filled of Helium which is heavy and has high amount of mass flow rate to WD hence shorter period. Porb < 1
most of the systems are between period minimum and 2 hours where the influencial mechanism is gravitational radiation

Period gap (2 ≤ Porb < 3)
here the secondary star undergoes high magnetic braking which results into

2(a) Evolution of Cataclysmic variable stars

is a binary system of stars (white dwarf and a companion star) where the gravitation ~~particle~~ potentials differ in every WD > Companion star (Secondary star).

When the critical point has been reached between the gravitaton potentials of the two stars, the mass starts to flow from the companion star to white dwarf which can either form an accretion disc on the white dwarf or not depending on the magnetic field strength of white dwarf.

Considering the nature of CVs, where they orbit each other, the distance and time taken for both of ~~them~~ to complete the their orbit also affects how they should evolve for example AM CVn where the companion is made of Helium which is heavey and have a high mass flow later at the same time shorter period of Orbiting

(1) ✓ Looking at how they looses angular momentum:

✓ Gravitation radiation is the loss of mass of the accretion disc due to the ~~gravita~~ formation of gravity waves on the ~~white dwarf~~ companion star which drive the matter away. ~~hence~~