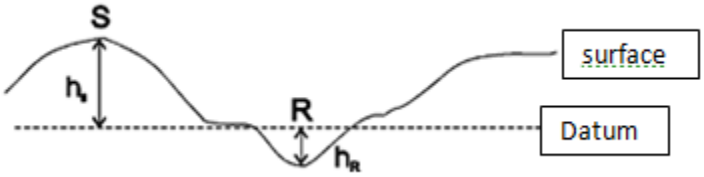
Name: Enrolment No:	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2018

Course: B.Tech GSE/GIE **Semester:** VII
Programme: Geophysical Data Acquisition, Processing & Interpretation (GSEG- 402)
Time: 03 hrs. **Max. Marks:** 100

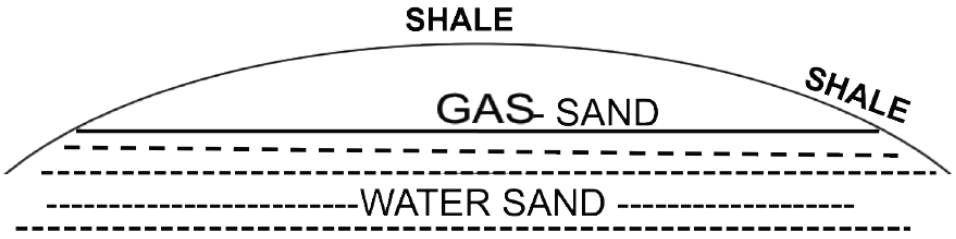
SECTION A

S. No.		Marks	CO
Q 1	What do you understand by an offlap? What does an offlap indicate in a seismic section?	2+2	CO3
Q 2	What will be the sign (+ve or –ve) and value for shot statics and receiver statics in the given surface topography: 	2+2	CO2
Q 3	What is Larmor frequency? Briefly explain the working principle of proton precession magnetometer.	2+2	CO1
Q 4	Calculate the thickness of the granite (2650 Kg/m^3) required to give an Bouguer anomaly of 10 mGal assuming the country rock density is 2750 kg/m^3.	04	CO4
Q 5	Which type of 4 layer master curve will form for the given sequence also give the relationship between the resistivities. Dry Soil Wet soil Hard rock Saline water aquifer	04	CO6

SECTION B

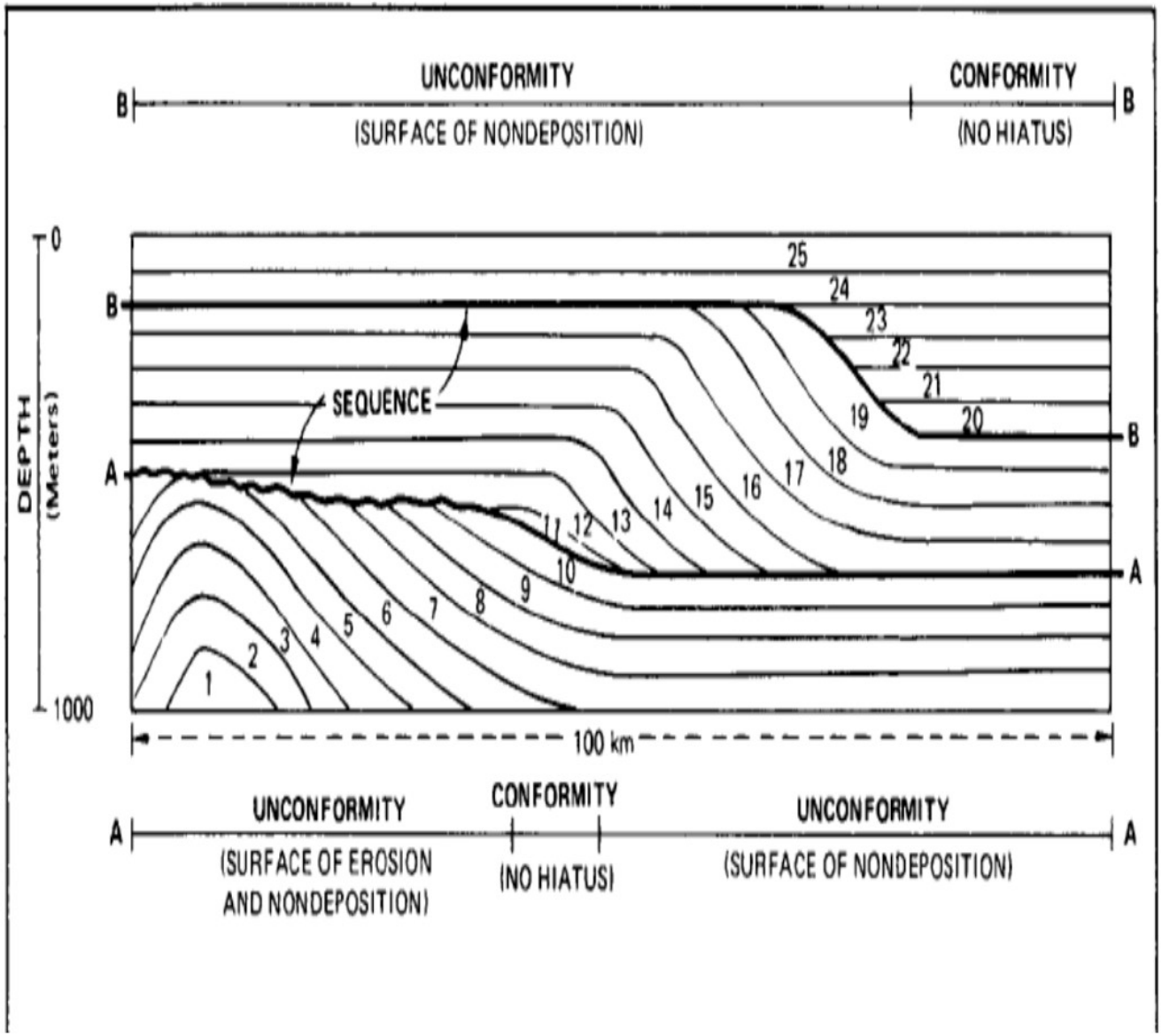
Q 6	Using Ohm's law, derive an expression for apparent resistivity using 4-electrode configuration for Schlumberger configuration.	10	CO6
Q 7	Stratigraphic features frequently are better imaged by Coherence Cube processing, a recently perfected methodology that maybe applied either after or during the processing of 3Dseismic data and utilized during the interpretation to further reveal the stratigraphic trap. A non- traditional procedure, Coherence Cube processing, processes 3D seismic data not for imaging reflections, but for imaging	5+5	CO2

	discontinuities by analyzing waveform similarity. Traces that are similar to each other are mapped with high-coherence coefficients, and when similarities end, discontinuities maybe inferred. As a consequence, when visualized in a 3D volume or cube, coherence coefficients enhance the detection and understanding of stratigraphic features (as well as faults) that are often not visible in traditionally processed data. Stratigraphic features are frequently difficult to see in seismic data due to the low level or chaotic nature of the seismic reflections they provide. Coherence Cube processing brings stratigraphic features into focus as it computes the variations in the waveform regardless of the amplitude of the reflectors. Lateral definition of these stratigraphic features can be seen best in the horizontal or time domain. In areas of high dip or where stratigraphic features transit different strati- graphic horizons, flattening of key surfaces, horizon slices, maybe beneficial in obtaining a greater understanding of the stratigraphy contained in the dataset. However, interpretive bias can enter the dataset when using horizon slices in tracing strati- graphic features, since a geoscientist is required to go through the difficult, time-consuming and subjective process of picking the horizon. The Coherence Cube technique increases the probability of finding hydrocarbons by indicating stratigraphic (and structural) traps that were not visible with traditional procedures. Estimates of 3D dimensional seismic coherence are obtained by calculating localized waveforms within the regular grid of a 3D seismic dataset. A sharp discontinuity is produced by stratigraphic boundaries. In areas such as the Gulf of Mexico, where high seismic amplitudes frequently indicate hydrocarbon accumulations, their stratigraphic milieu is more readily identified from coherence data because they provide a different perspective in combination with amplitude data. a. Briefly explain how ‘coherency attribute’ helps in detecting a fault? b. For a basin having only fault-related traps, 3D seismic volume on a time slice of 540 ms shows two anomalies A and B with high amplitudes. A is associated with lower coherence coefficient while B is with comparatively higher coherence coefficient value. Out of A and B which anomaly should be drilled and why?		

Q 8	Briefly discuss any three seismic DHIs? For the model given below sketch a stack seismic response showing appropriate DHIs.  	**6+4**	**CO3**
Q 9	a.If the measured current is 5 mA using 15m as the distance between two consecutive current electrodes and the potential difference is 20 V. What will be the resistance and the apparent resistivity of the subsurface? b. How will you distinguish between the normal regression of lowstand and highstand from the seismic section?	**5+5**	**CO6**
SECTION-C			
Q 10	**<u>Case study: Growing Importance of non-seismic methods in hydrocarbon exploration</u>** Petroleum exploration involves high science & high technology with huge expenditure. In the low price regime of petroleum, it is necessary to minimise exploration costs. Thanks to modern techniques in Gravity-Magnetic (GM) and Magneto-telluric (MT) that are popularly known as Non-seismic methods through which sub-surface imaging is cost effective, cover large areas rapidly, non-invasive and environment friendly way. India is importing nearly 80% of its petroleum requirements in spite of having 26 sedimentary basins along with large offshore exclusive economic zones. Its exploration efforts are hampered partly due to half of these basins are seismically challenging and lack of awareness about modern GM & MT techniques. Since the dawn of 21st century across the world more than hundred giant Oil & Gas fields including thirty super giants were discovered. India being a sub-continent might have huge deposits of petroleum, hither to hidden and are to be discovered. The first step in exploration is imaging of sub-surface. During early twentieth century imaging was carried out with the help of Gravity-Magnetic surveys. Soon Seismic imaging changed the Oil & Gas exploration and continues to play a vital role though it has limitations such as limited energy penetration in trap covered areas and environmental issues. Here the importance and advantage of Gravity-Magnetic over Seismic is that the GM data can be acquired from air and cover large areas in short time overcoming logistic difficulties. Latest developments	**5+5+5 +5**	**CO5**

	in instrumentation, high speed computers with ability to handle large volume of data, improvements in Satellite positioning made GM & MT techniques made possible dramatic changes in the exploration arena. Some of the latest techniques are Microgravity, Airborne Gravity Gradiometry (Tensor gravity) and Borehole Gravity (BHG). The acquisition cost of GM & MT data is considerably less. In today's risk averse and environmentally aware exploration world, in geologically complex areas non-seismic techniques are the best bet for unrevealing the mysteries of sub-surface. Currently, Russia, China operates more than hundred GM & MT Geophysical Field Parties for Oil and Gas exploration. Australia, Brazil, and even less developed countries like Peru, Ghana, Tanzania, Angola, etc. have fully covered their countries with Aero Gravity-Magnetic surveys. Tensor Gravity data helped to reprocess seismic data for imaging below pre-salt structures in the extensively explored Gulf of Mexico and Brazil Offshore, resulting discovery of giant fields. Realising the importance of Non-Seismic techniques in petroleum exploration in India Microgravity surveys were carried out to identify low density sands that are envisaged to be gas bearing and validated by drilled wells. Basement maps have been prepared based on GM & MT data in trap covered XYZ basin and ABC basin. The XYZ map indicated that a ridge connecting basement exposed Bundelkhand with Hosangabad is the one separating Chambal Valley and Sone Valley. Whereas, Basement map of ABC brought out clearly major and minor faults. Combining ship borne Gravity-Magnetic data in these areas not only given basement depth map but also identified major structural elements. It is time to strengthen GM & MT studies for hydrocarbon exploration in India, especially in all the category III & IV basins. In simple terms, Magnetic data infers basement configuration along with faults of a sedimentary basin. Gravity data identifies the low density zones if any and MT data over these low density zones discriminates between water and hydrocarbons. In this way integration of all these data can unravel the mysteries of the sub-surface and considerably reduce exploration risk with minimum cost. Based on the above case study answer the following questions: a) Compare the advantages and disadvantage of seismic and non-seismic methods of hydrocarbon exploration. b) Prepare a flowchart representing the interpretation flow for detecting a hydrocarbon zone based on non-seismic methods c) “Soon Seismic imaging changed the Oil & Gas exploration and continues to play a vital role though it has limitations such as limited energy penetration in trap (igneous) covered areas.” – Why it difficult to produce the high resolution seismic image for deeper structures? d) “Magnetic data infers basement configuration”- Justify the statement.		

Q 11	a. Given constant rate of sediment supply, mark all the system tracts on the sea level curve? Indicate point of location for Maximum Flooding Surface (MFS) in the digram? b. Analyze the stratigraphic sequences in the section below. c. Prepare a chronostratigraphic chart indicating the type of hiatus formed at unconformities**.** d. Identify toplap/offlaps, downlap, onlap, concordance, erosional truncation in the given pseudo seismic section. Note: Interpreted seismic section need to be attached along with the answer sheet	**5+2+8 +5**	**CO3**


UNCONFORMITY
(SURFACE OF NONDEPOSITION)
CONFORMITY
(NO HIATUS)
B
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DEPTH
(Meters)
SEQUENCE
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(SURFACE OF EROSION
AND NONDEPOSITION)
CONFORMITY
(NO HIATUS)
UNCONFORMITY
(SURFACE OF NONDEPOSITION)
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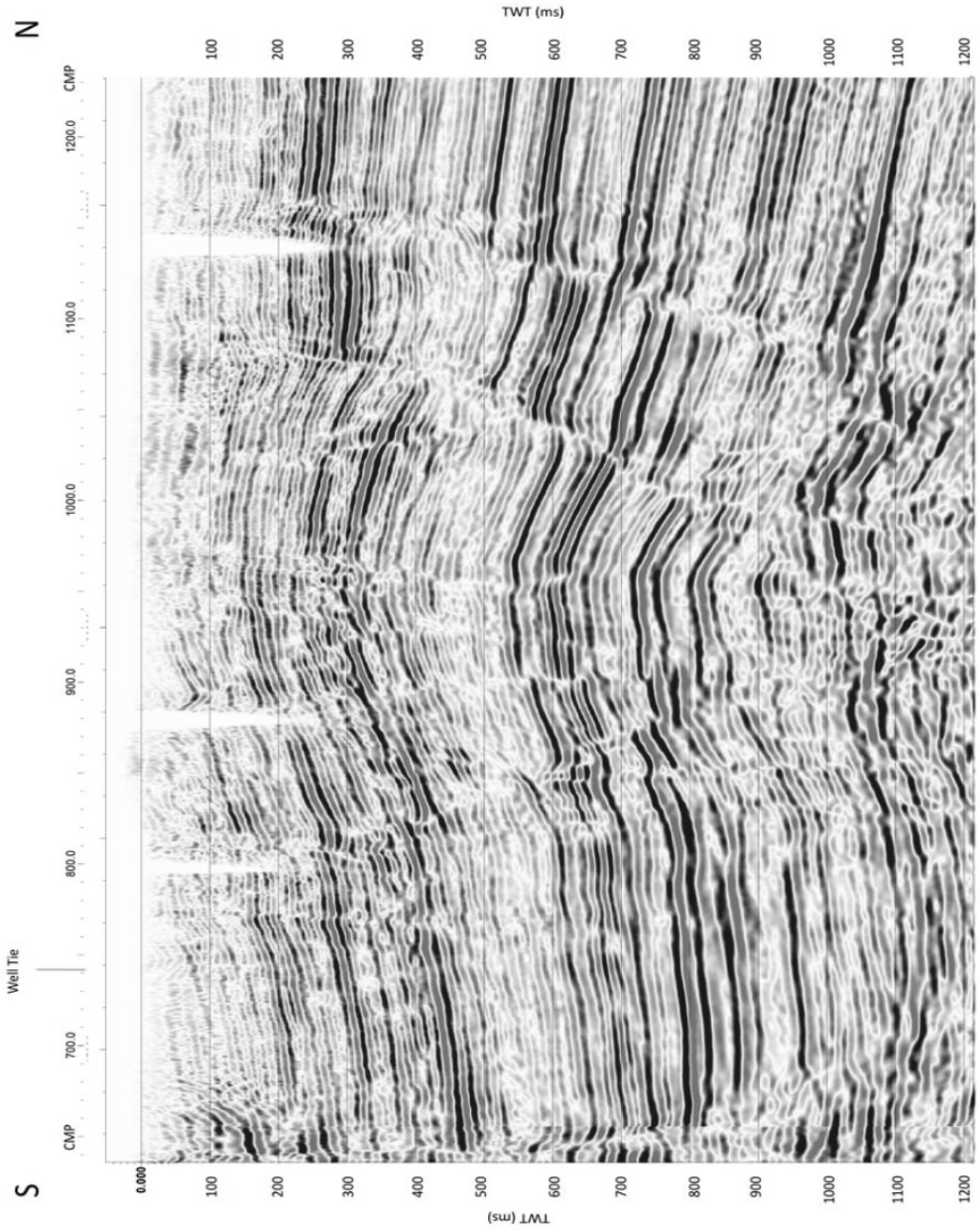
SECTION A

S. No.		Marks	CO
Q 1	What do you understand by an onlap? Does onlap signifies marine regression? Comment?	2+2	CO3
Q 2	Give importance of seismic attribute? Give an example of seismic attribute and its utility.	2+2	CO1
Q 3	What do you understand by magnetic declination? At what point on earth the magnetic inclination is zero?	2+2	CO5
Q 4	In an unmigrated seismic section, how an anticline appears? Illustrate your answer using suitable diagram	2+2	CO2
Q 5	Given data of a Library as follows: Gravity at the roof: 0.970 mGal and Gravity at the bottom: 0.990 mGal. Calculate height of the library building?	04	CO4
	SECTION B		
Q 6	What do you understand by seismic DHIs? Differentiate a) bright spot, b) flat spot and c) a pull down effect in a seismic section?	4+6	CO3
Q 7	How seismic migration happen? What conditions lead to seismic migration? Derive an expression for horizontal resolution of seismic data?	5+5	CO2
Q 8	Using 4-electrode configuration for Wenner configuration, derive an expression for apparent resistivity?	10	CO6
Q 9	Derive an expression for acceleration due to gravity for a spherical body. A spherical cavity of radius 8 m has its centre 15 m below the surface. If the cavity is full of sediments of density 1.5×10^3 kg/m3 and is in a rock body of density 2.4×10^3 kg/m3. What is the maximum value of its gravity anomaly in mGal?	5+5	CO4

<table>
<tr><th colspan="4">SECTION-C</th></tr>
<tr><td>Q 10</td><td>List 4- system tracts? What are their significance?
Show how system tracts are seen in seismic data using suitable diagram?</td><td>4+6+
10</td><td>CO3</td></tr>
<tr><td>Q 11</td><td>This is an exercise to locate any structural features on the seismic data that could act as trap for hydrocarbons. Working geophysicists called interpreters do this on seismic data all the time.
A seismic profile was shot from South to North, with the low CMP numbers in the South. A borehole was drilled on this seismic line at CMP 740 and from this we know the lithology and stratigraphic sequence at that location. Geophysical measurements taken down this borehole allow us to link the horizons on the seismic section to the real lithology. This is called the well tie.
Using the results of the well tie, we can identify the following horizons and rock units:
<table>
<tr><th>Horizon</th><th>Rock Type</th></tr>
<tr><td>Trough at 424ms</td><td>Purbeck Sandstone</td></tr>
<tr><td>Peak at 710ms</td><td>Kimmeridge Clay</td></tr>
<tr><td>Zero crossing positive to negative at 959ms</td><td>Corallian Limestone</td></tr>
</table>
Using this information we are now ready to interpret the seismic profile.
a. Locate the well tie position on the top of the seismic section, and directly under that point mark the time of the horizons specified in the well tie using a different coloured pencil for each one. The very black events are peaks, the greyer ones troughs and zero crossings are white.
b. Taking one horizon at a time, follow the peak or trough across the whole section (it may be easier to use a lead pencil to mark your progress). A zero crossing is the changeover point from either a peak to a trough (positive to negative), or a trough to a peak (negative to positive). The horizon may not be continuous all the way across the profile. Try to think about possible structures to explain any jumps or breaks in the horizon, (faults for example). Remember if you think you see a break that could be a fault, you should see a similar break in the horizons above and below. When you are confident you can see where the horizon goes, colour it with your chosen colour.
c. Mark any faults on the section with a lead pencil. Try to describe it, e.g. it is a normal/reverse fault, downthrow side to the north/south, throw approximately xxms
d. Indicate locations suitable for structural traps.
Note: Interpreted seismic section need to be attached along with the answer</td><td>5+5+5
+5</td><td>CO5</td></tr>
</table>

	sheet		


N
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TWT (ms)
CMP
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