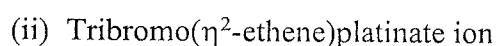
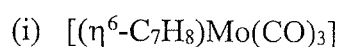


Department : Chemistry
Level : 5
Name of the Examination : Final Examination
Course Code and Title : **CYU5300 – Organometallic Chemistry**
Academic Year : 2025/2026
Date : 05 -12-2025
Time : 2.00 p.m. – 04.00 p.m.
Duration : 02 hours
Index number :

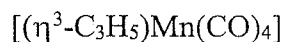
1. Read all instructions carefully before answering the questions.
2. This question paper consists of **05** pages containing **04** questions.
3. Answer **all four** questions. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. Draw fully labelled diagrams where necessary.
5. Relevant log tables are provided where necessary.
6. Having any unauthorized documents/ mobile phones in your possession is a punishable offense.
7. Use blue or black ink to answer the questions.
8. Circle the number of the questions you answered in the front cover of your answer script.
9. Clearly state your index number in your answer script.

01. (a) Give the IUPAC name of $[\text{Ti}(\eta^5\text{-C}_5\text{Me}_5)_2(\eta^2\text{-CH}_2=\text{CH}_2)]$ (10 marks)

(b) Draw the structures of the following complexes. (20 marks)

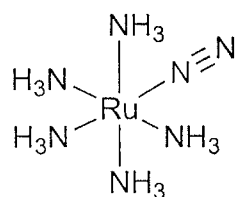


- (c) (i) Determine the Valence Electron Count (VEC) of the following complex using the **Ionic model**.



(Hint: Indicate in your workout, the electron contribution from each ligand, Mn is a group 7 element)

- (ii) What is the coordination number of **Mn** in this complex? (15 mark)
- (d) Draw and identify the structure of each of the following compounds.
- (i) $[\text{Mo}(\text{CO})_4(\text{PPh}_2\text{CH}_2\text{CH}_2\text{PPh}_2)]$
- (ii) $[\text{Co}(\text{CO})_4]^-$ (20 marks)
- (e) Draw **all** possible isomers of the following complex $[\text{MnBr}_2\text{Cl}_2(\text{CO})_2]$ (20 marks)
- (f) Describe the bonding between Ru and dinitrogen (N_2) in the given complex, using appropriate orbital diagrams. (15 marks)



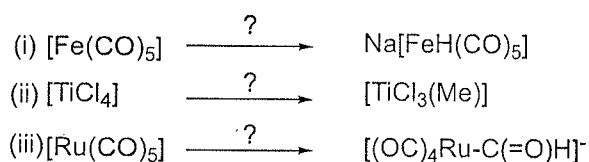
02. (a) Arrange $\text{H}_2\text{C}=\text{CH}_2$, $\text{FCH}=\text{CHF}$ and $\text{MeCH}=\text{CHMe}$, in the order of **increasing** π -acceptability (reasons not required). (10 marks)
- (b) Explain why $[\text{Ni}(\text{CO})_4]$ complex is stable at room temperature, whereas $[\text{Ni}(\text{NH}_3)_4]$ complex is not stable. (20 marks)

- (c) How would you account for the variation in the CO stretching frequencies in the following compounds?

(25 marks)

Compound	$\nu(\text{CO})$ in cm^{-1}
Free CO	2135
$[\text{Mo}(\text{CO})_3(\text{PCl}_3)_3]$	2040, 1991
$[\text{Mo}(\text{CO})_3(\text{PEt}_3)_3]$	1937, 1841

- (d) Suggest reagents to carry out the following conversions.

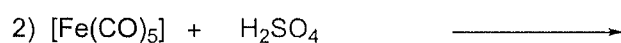
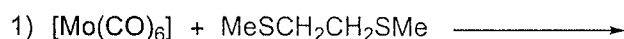


(15 marks)

- (e) State whether the following statements are **true or false (T/F)**. (30 marks)

- (i) Nucleophilic attack of Me^- on a coordinated ligand is facilitated if the complex is coordinatively saturated (T/F).
 (ii) Electrophilic attack of Me^+ on a coordinated $\text{CH}_2=\text{CH}_2$ is facilitated if the complex is coordinatively unsaturated (T/F).
 (iii) Electrophilic attack of Me^+ is more facile on $[(\eta^5\text{-C}_5\text{Me}_5)\text{Rh}(\text{C}\equiv\text{CPh})(\text{CO})]^-$ than $[(\eta^5\text{-C}_5\text{Me}_5)\text{Rh}(\text{C}\equiv\text{CPh})(\text{CO})]$ (T/F).
 (iv) Cyclometallation reaction of a coordinated ligand is facilitated if the metal is coordinatively saturated (T/F).
 (v) Cyclometallation reaction of $[\text{IrMe}(\text{PMe}_3)_3]$ may give a 3-membered metallacycle via C-H bond activation (T/F).
 (vi) For oxidative coupling to take place, M^{n+} metal center must have an energetically accessible oxidation state $\text{M}^{(n+2)+}$ (T/F).

03. (a) (i) Predict the product(s) of the following reactions.



(20 marks)

(ii) $[\text{Mo}(\text{CO})_6]$ reacts with two moles of PPh_3 to give a tetracarbonyl $\text{Mo}(0)$ complex **B**. **B** shows only one IR band in the carbonyl region. Draw the structure of **B**.

(10 marks)

(b) Palladium complexes are widely used in catalysis. What are the main reasons for this? (15 marks)

(c) (i) How does a catalyst speed up a reaction? (10 marks)

(ii) Give a reaction profile to show the action of a catalyst (15 marks)

(iii) Define the terms Turnover number (TON) and Turnover frequency (TOF) (10 marks)

(iv) In the presence of a palladium catalyst (0.0002 mmol), MeI (8.0 mmol) reacts with $\text{MeCH}=\text{CH}_2$ (8.0 mmol) to give butene (80% yield). The reaction time is 20 min. Calculate the (TON) and Turn over frequency (TOF) (20 marks)

04. Predict the major product(s) formed in each of the following reactions, using the hint given in brackets.

(100 marks)

