Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2019

Course: Corrosion Engineering **Semester:** V
Program: B. Tech (APE Gas) **Time 03 hrs.**
Course Code: MTEG365 **Max. Marks: 100**
Instructions: *The question paper consists of three sections. Answer the questions section wise in the answer booklet.
Note: Assume suitable data if necessary

SECTION A
Answer all questions

S. No.		Marks	CO
Q 1	**Explain** bimetallic corrosion and its prevention.	**5**	**CO1**
Q 2	**Discuss** about corrosion laws.	**5**	**CO2**
Q 3	**Explain** about polarization and passivity.	**5**	**CO1**
Q 4	**Illustrate** typical changes in the environment that can prevent corrosion.	**5**	**CO3**
	SECTION B **Answer all questions**		
Q 5	**Criticize** corrosion in soil environment.	**10**	**CO3**
Q 6	**Summarize** pourbaix diagram for iron in water system.	**10**	**CO2**
Q 7	**Discuss** metallurgical failure analysis**.**	**10**	**CO4**
Q 8	**Predict** whether zinc (Zn) is stable in aqueous solutions of HCl with pH between 0 and 5. The initial concentration of $ZnCl_2$ is 10^{-6} M. The activity coefficients are assumed 1. The hydrogen pressure is 1 atm.	**10**	**CO2**
	SECTION-C **Answer all questions**		
Q 9	**Discuss** the physical metallurgy of titanium alloys. Explain the mechanical properties and corrosion behavior of titanium in specific environment.	**20**	**CO5**
Q 10	1. Derive corrosion potential and corrosion current. 2. Consider iron in a solution with a pH of 7 saturated with oxygen and a partial pressure of oxygen, P_{O_2} = 1atm. **Calculate** the corrosion current and the corrosion potential. Additional information: $[Fe^{2+}]$ = 0.7 M, P_{O_2} = 1 atm B_a = 0.08V/decade, β_c = -0.11 V/decade i^o_{Fe} = 10^{-5} A/cm^2, i^o_{OH-} = 10^{-6} A/cm^2	**(10+10)**	**CO3**

Table: Standard Electrode Potentials at 25 $^{\circ}$C and Their Isothermal Temperature Coefficients

Electrode	Reaction	$e^{o}\ (V\ vs\ SHE)$	$\left(\frac{dE^{o}}{dT}\right) \times 10^{3} \left(\frac{V}{^{o}C}\right)$
$Li^{+}\|Li$	$Li^{+} + e^{-} = Li$	—3.045	—0.534
$Rb^{+}\|Rb$	$Rb^{+} + e^{-} = Rb$	—2.925	—1.245
$Cs^{+}\|Cs$	$Cs^{+} + e^{-} = Cs$	—2.923	—1.197
$K^{+}\|K$	$K^{+} + e^{-} = K$	—2.925	—1.080
$Ra^{2+}\|Ra$	$Ra^{2+} + 2e^{-} = Ra$	—2.916	—0.59
$Ba^{2+}\|Ba$	$Ba^{2+} + 2e^{-} = Ba$	—2.906	—0.395
$Ca^{2+}\|Ca$	$Ca^{2+} + 2e^{-} = Ca$	—2.866	—0.175
$Na^{+}\|Na$	$Na^{+} + e^{-} = Na$	—2.714	—0.772
$La^{3+}\|La$	$La^{3+} + 3e^{-} = La$	—2.522	+0.085
$Mg^{2+}\|Mg$	$Mg^{2+} + 2e^{-} = Mg$	—2.363	+0.103
$Be^{2+}\|Be$	$Be^{2+} + 2e^{-} = Be$	—1.847	+0.565
$Al^{3+}\|Al$	$Al^{3+} + 3e^{-} = Al$	—1.662	+0.504
$Ti^{2+}\|Ti$	$Ti^{2+} + 2e^{-} = Ti$	—1.628	-
$Zr^{4+}\|Zr$	$Zr^{4+} + 4e^{-} = Zr$	—1.529	-
$V^{2+}\|V$	$V^{2+} + 2e^{-} = V$	—1.186	-
$Mn^{2+}\|Mn$	$Mn^{2+} + 2e^{-} = Mn$	—1.180	—0.08
$Zn^{2+}\|Zn$	$Zn^{2+} + 2e^{-} = Zn$	—0.762	+0.09
$Cr^{3+}\|Cr$	$Cr^{3+} + 3e^{-} = Cr$	—0.744	+0.468
$SbO_2^{-}\|Sb$	$SbO_2^{-} + 2H_2O + 3e^{-} = Sb + 4OH^{-}$	—0.670	-
$Ga^{3+}\|Ga$	$Ga^{3+} + 3e^{-} = Ga$	—0.529	+0.67
$S^{2-}\|S$	$S + 2e^{-} = S^{2-}$	—0.510	-
$Fe^{2+}\|Fe$	$Fe^{2+} + 2e^{-} = Fe$	—0.440	+0.052
$Cr^{3+}, Cr^{2+}\|Pt$	$Cr^{3+} + e^{-} = Cr^{2+}$	—0.408	-
$Cd^{2+}\|Cd$	$Cd^{2+} + 2e^{-} = Cd$	—0.402	—0.093
$Ti^{3+}, Ti^{2+}\|Pt$	$Ti^{3+} + e^{-} = Ti^{2+}$	—0.369	-
$Tl^{+}\|Tl$	$Tl^{+} + e^{-} = Tl$	—0.336	—1.327
$Co^{2+}\|Co$	$Co^{2+} + 2e^{-} = Co$	—0.277	+0.06
$Ni^{2+}\|Ni$	$Ni^{2+} + 2e^{-} = Ni$	—0.250	+0.06
$Mo^{3+}\|Mo$	$Mo^{3+} + 3e^{-} = Mo$	—0.20	-
$Sn^{2+}\|Sn$	$Sn^{2+} + 2e^{-} = Sn$	—0.138	—0.282
$Pb^{2+}\|Pb$	$Pb^{2+} + 2e^{-} = Pb$	—0.126	—0.451
$Ti^{4+}, Ti^{3+}\|Pt$	$Ti^{4+} + e^{-} = Ti^{3+}$	—0.040	-
$H^{+}, H_2\|Pt$	$H^{+} + e^{-} = ½\ H_2$	T0.000	T0.000 (+0.871)^{m}
$Sn^{4+}, Sn^{2+}\|Pt$	$Sn^{4+} + 2e^{-} = Sn^{2+}$	+ 0.015	-
$Cu^{2+}, Cu^{+}\|Pt$	$Cu^{2+} + e^{-} = Cu^{+}$	+ 0.153	+0.073
$Cu^{2+}\|Cu$	$Cu^{2+} + 2e^{-} = Cu$	+0.337	+0.008
$Fe(CN)_6^{3-}, Fe(CN)_6^{4-}\|Pt$	$Fe(CN)_6^{3-} + e^{-} = Fe(CN)_6^{4-}$	+0.360	-
$OH^{-}, O_2\|Pt$	$½\ O_2 + H_2O + 2e^{-} = 2OH^{-}$	+0.401	—0.440
$Cu^{+}\|Cu$	$Cu^{+} + e^{-} = Cu$	+0.521	—0.058
$I^{-}\|I_2, Pt$	$I_2 + 2e^{-} = 2I^{-}$	+0.535	—0.148
$MnO_4^{-}, MnO_4^{2-}\|Pt$	$MnO_4^{-} + e^{-} = MnO_4^{2-}$	+0.564	-