Interview for candidates with a degree in Chemical Engineering:
Sample questions

> ***Note:*** *Candidates with degrees in disciplines other than Chemical Engineering will be tested for their knowledge of the basic concepts in their disciplines, their general analytical skills, and their suitability for our programme.*

Mathematics

- Write the Taylor series expansion of a function $f(x)$ around $x = x_0$.
- Find the eigenvalues of a 2x2 matrix.
- What is the procedure for solving a system of linear equations using the Gauss-elimination method.
- What is the rank of a matrix? If the rank of an $n \times n$ matrix is less than n, what can you infer about its determinant?
- Obtain the limit of $\sin x/x$ as $x \to 0$. What is the limit of $\cos x/x$ as $x \to 0$.
- What is the integral of the Dirac delta function $\delta(x)$ for x ranging from $-\infty$ to ∞.
- What is the probability of getting more than 10 when one throws a pair of dice together? What will be the probability if the dice are thrown one after the other?
- What is the general solution of the differential equation $d^2y/dx^2 + 4y = 3x$?
- Solve the following differential equation using Laplace transforms: $y'' - y = t$, with initial conditions $y'(0)=1$, $y(0) = 1$.
- Determine the Laplace transform (with respect to t) of: (1) $y=1$, (2) $y=t$.
- What is the equation of a circle in the rectangular Cartesian (x-y) coordinate system? Obtain the area of a circle of unit radius using this coordinate system.
- Attempt to solve the equation $x = 2 \sin x$ graphically. Can you solve this equation iteratively?
- What do you understand by divergence of a vector function? Obtain it for a 2-d vector.
- Express the function $f(x) = x$ from $-\pi$ to π in a Fourier series.
- Solve the unsteady state heat conduction equation for a sphere/plane of temperature $T=T_0$ in an infinite conducting medium whose initial temperature is T=0.

Chemical Engineering

- Sketch Carnot cycle in the P-V plane for an ideal gas.
- What is the efficiency of a Carnot engine, and why is it not unity?
- Why is a pressure cooker effective in cooking?
- Why are the wet and dry bulb temperatures different? When will these be equal?
- Apply Le Chatelier's principle to the reversible gas-phase reaction $A+B \rightarrow C$, and explain how the equilibrium conversion will vary with pressure.
- Determine qualitatively the concentrations versus time of all the species in a batch reactor for a series reaction $A \rightarrow B \rightarrow C$ with rate constants k_1 and k_2. Is it possible to simplify the problem if $k_1 << k_2$?

- What is the pH of a 0.02 N HCl solution?
- What is the design equation for a PFR (plug flow reactor).
- What is the design equation for a CSTR, and how would you use it to determine the volume of a reactor required to obtain a certain conversion for the reaction $A \rightarrow B + C$ for a given inlet flow rate of the component A.
- Write/derive the unsteady state mass balance for a CSTR.
- What is a Newtonian fluid? How does it differ from a Bingham plastic fluid?
- What is the velocity profile for flow of a Newtonian fluid in a cylindrical tube. What is it for a Bingham plastic fluid?
- Apply Bernoulli's equation to a Venturi meter and show how it is used to measure the flow rate of a fluid.
- Indicate the forces acting on spherical particle falling in a liquid. Use Stokes law to derive an expression for the terminal velocity.
- How is a spin bowler able to "drift" or "dip" a cricket ball from its normal trajectory? Similarly, how is a footballer able to "bend" the ball to reach the goalpost?
- Why does water freeze on a cold night even when the ambient temperature is not sub-zero?
- A furnace is insulated with a two-layer wall, of thicknesses 10 cm (inner) thick and 20 cm (outer). The thermal conductivities of the two layers are 0.05 and 0.1W/m/°C, respectively. If the furnace is at a temperature of 200°C and the ambient air is at 30°C, draw the steady state temperature profile across the insulating wall if the heat transfer resistance of the ambient air is assumed to be zero. How would it change if the heat transfer coefficient from outer wall to air is 20 $W/m^2/°C$?
- How is Fick's first law related to mass transfer by diffusion? What is its analogue in heat transfer?
- If there are no constraints, how would you conduct a stage-wise distillation column so as to bring its efficiency closer to unity?
- Consider a sphere and a cube of the same volume and having the same initial temperature T_0. If both are exposed to the same external temperature T_e ($> T_0$), which would gain heat faster?