# List of Figures

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Figure</th>
<th>Title</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td></td>
<td>Representation of (a) use of ‘hair gel’ in ancient days and (b) a modern ‘hair gel’</td>
<td>2</td>
</tr>
<tr>
<td>1.2</td>
<td></td>
<td>Examples of some natural sources of gels: (a) Aloe vera leaves, (b) Carrageenan, (c) Xanthan Gum and (d) Propolis</td>
<td>4</td>
</tr>
<tr>
<td>1.3</td>
<td></td>
<td>Urea-based gelators of organic solvents</td>
<td>5</td>
</tr>
<tr>
<td>1.4</td>
<td></td>
<td>Different types of water in hydrogel</td>
<td>7</td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td>Swelling measurement of a hydrogel</td>
<td>9</td>
</tr>
<tr>
<td>1.6</td>
<td></td>
<td>(a) Trimethylol propane trimethacrylate, (b) 2-hydroxy trimethylene dimethacrylate, (c) 2,3-dihydroxy tetramethylene dimethacrylate and (d) hexamethylene bis-(methacryloyloxy-ethylene carbamate)</td>
<td>14</td>
</tr>
<tr>
<td>1.7</td>
<td></td>
<td>The reaction of α,ω-hydroxyl poly(ethylene glycol) with a diisocyanate in the presence of a triol as crosslinker</td>
<td>15</td>
</tr>
<tr>
<td>1.8</td>
<td></td>
<td>Crosslinking by (a) Glutaraldehyde and (b) Detranaldehyde</td>
<td>15</td>
</tr>
<tr>
<td>1.9</td>
<td></td>
<td>Representation of ionically crosslinked chitosan and sodium alginate hydrogel</td>
<td>16</td>
</tr>
<tr>
<td>1.10</td>
<td></td>
<td>Stimuli-responsive swelling of hydrogel</td>
<td>17</td>
</tr>
<tr>
<td>1.11</td>
<td></td>
<td>pH-dependent ionization of polyelectrolytes: (a) poly(acrylic acid) and poly(N,N'-diethylaminoethyl methacrylate)</td>
<td>19</td>
</tr>
<tr>
<td>1.12</td>
<td></td>
<td>Structure of some thermo-responsive polymeric hydrogels</td>
<td>20</td>
</tr>
<tr>
<td>1.13</td>
<td></td>
<td>Schematic diagram of the apparatus for testing the bending behaviour of hydrogel under an applied electric field</td>
<td>25</td>
</tr>
</tbody>
</table>
1.14 Electro-actuation behaviour of polyelectrolyte hydrogel at different time interval 26
1.15 Schematic representation of the steps involved in preparation of a hydrogel based drug delivery system 27
1.16 Schematic illustration of oral colon-specific drug delivery using pH-sensitive hydrogels 29
1.17 Schematic representation of drug release behavior from electro-responsive hydrogels due to electro-induced deswelling-swelling behavior 31

Chapter 2:

2.1 Schematic representation of preparation of poly(AAm-co-AAc)/PANI composite hydrogel 52
2.2 Schematic representation for the preparation of poly(AAm-co-AAc)/graphite composite hydrogel 53
2.3 Apparatus for measuring bending angle 56
2.4 FTIR spectra of (a) polyaniline (PANI) and (b) poly(AAm-co-AAc)/PANI composite hydrogel 58
2.5 UV-visible spectra of (a) polyaniline (PANI) and (b) poly(AAm-co-AAc)/PANI composite hydrogel 59
2.6 XRD spectra of (a) poly(AAm-co-AAc) copolymer hydrogel, (b) poly(AAm-co-AAc)/PANI composite hydrogel and (c) polyaniline 60
2.7 SEM micrographs of (a) poly(AAm-co-AAc) copolymer hydrogel, (b) poly(AAm-co-AAc)/PANI composite hydrogel and (c) cross-section of poly(AAm-co-AAc)/PANI composite hydrogel 61
2.8 Tensile strengths of the hydrogels with the variation of crosslinker 62
2.9 Swelling % of poly(AAm-co-AAc) copolymer hydrogels in different pH medium: (a) pH 4, (b) distilled water and 65
2.10 Swelling % of poly(AAm-co-AAc)/PANI composite hydrogels in different pH medium: (a) pH 4, (b) distilled water and (c) pH 7.4

2.11 Effective bending angles of poly(AAm-co-AAc)/PANI composite hydrogels in: (a) 0.1 N NaCl solution and (b) 0.2 N NaCl solution

2.12 Effective bending angles of poly(AAm-co-AAc)/PANI composite hydrogels with respect to time

2.13 The percentage of hemolytic activity of poly(AAm-co-AAc)/PANI composite hydrogels at concentration (5 mg/2ml) at 540 nm

2.14 FTIR spectrum of poly(AAm-co-AAc)/graphite composite hydrogel

2.15 XRD spectra of (a) poly(AAm-co-AAc) copolymer hydrogel and (b) poly(AAm-co-AAc)/graphite composite hydrogel

2.16 SEM images of (a) poly(AAm-co-AAc) copolymer hydrogel and (b) poly(AAm-co-AAc)/graphite composite hydrogel

2.17 Tensile strength of the poly(AAm-co-AAc)/graphite composite hydrogels (with different amount of crosslinker)

2.18 Conductivity of the poly(AAm-co-AAc)/graphite composite hydrogels with the variation of crosslinker amount

2.19 Conductivity of the poly(AAm-co-AAc)/graphite composite hydrogels with the variation of graphite amount

2.20 Conductivity of the poly(AAm-co-AAc)/graphite composite hydrogels
composite hydrogels with the variation of temperature

2.21 Swelling % of poly(AAm-co-AAc) copolymer hydrogel in different pH medium: (a) pH 4, (b) distilled water and (c) pH 7.4

2.22 Swelling % of poly(AAm-co-AAc)/graphite composite hydrogels in different pH medium: (a) pH 4, (b) distilled water and (c) pH 7.4

2.23 Effective bending angles of poly(AAm-co-AAc)/graphite composite hydrogels in: (a) 0.1 N NaCl solution and (b) 0.2 N NaCl solution

2.24 Effective bending angles of poly(AAm-co-AAc)/graphite composite hydrogels with respect to time

2.25 Bar diagram showing the percentage of hemolytic activity by different samples at concentration (10 mg/2ml) at 540 nm

Chapter 3:

3.1 Schematic representation for the preparation of PVA-g-PAAc/OMMT nanocomposite hydrogel

3.2 Apparatus for measuring bending angle

3.3 Representative FTIR spectra of (a) OMMT nanoclay, (b) PVA-g-PAAc copolymer and (c) PVA-g-PAAc/OMMT nanocomposite hydrogel

3.4 XRD pattern of PVA-g-PAAc copolymer hydrogel

3.5 XRD patterns of (a) OMMT nanoclay and (b) PVA-g-PAAc/OMMT nanocomposite hydrogel

3.6 SEM micrographs of (a) PVA-g-PAAc hydrogel and (b) PVA-g-PAAc/OMMT nanocomposite hydrogel

3.7 TGA curves of (a) PVA-g-PAAc/OMMT nanocomposite hydrogel and (b) PVA-g-PAAc hydrogel

3.8 Swelling curves of PVA-g-PAAc/OMMT nanocomposite
hydrogel with various crosslinker amounts

3.9 Effect of OMMT nanoclay content on the swelling properties of PVA-g-PAAc/OMMT nanocomposite hydrogel

3.10 Effect of aqueous NaCl solution concentration on the equilibrium bending angle (EBA) at different applied voltages

Chapter 4:

4.1 Proposed reaction mechanism for the formation of CMC-g-PAAc/OMMT nanocomposite hydrogel

4.2 FTIR spectra of (a) pure OMMT nanoclay, (b) CMC-g-PAAc copolymer and (c) CMC-g-PAAc/OMMT nanocomposite hydrogels

4.3 XRD patterns of (a) Pure OMMT nanoclay and (b) CMC-g-PAAc/OMMT nanocomposite hydrogel (10 wt% OMMT nanoclay)

4.4 SEM images of (a) CMC-g-PAAc copolymer and (b) CMC-g-PAAc/OMMT nanocomposite hydrogel (10 wt% OMMT nanoclay)

4.5 Dynamic mechanical analysis of CMC-g-PAAc/OMMT nanocomposite hydrogel as a function of frequency: (a) Storage Modulus ($G'$) and (b) Loss Modulus ($G''$) with OMMT nanoclay content from 0-20 wt%

4.6 Influence of preparation conditions on the swelling behaviours of the nanocomposite hydrogel: (a) KPS content, (b) MBA content and (c) OMMT-nanoclay content

4.7 Hemolysis results: (a) Hemolysis percentage of the nanocomposite hydrogels without nanoclay (NP-1) and
with nanoclay (NP-3, 10 wt%), (b) Photographs of RBCs treated with different samples (NP-1, NP-3)

4.8 The vitamin B\textsubscript{12} release profile from the CMC-g-PAAc/OMMT nanocomposite hydrogels: (a) With different pH values at pH 1.2 and 7.4 (MP-4), (b) With different crosslinker content (0.05-0.25 wt%)

Chapter 5:

5.1 Schematic representation for the formation of gelatin-g-PAAc/MWCNT-COOH nanocomposite hydrogel

5.2 Apparatus for electro-responsive drug delivery

5.3 FTIR spectra of (a) MWCNT-pristine, (b) MWCNT-COOH, (c) gelatin-g-PAAc/MWCNT-COOH nanocomposite hydrogel and (d) gelatin-g-PAAc hydrogel

5.4 XRD patterns of (a) MWCNT-pristine and (b) MWCNT-COOH

5.5 XRD patterns of (a) gelatin-g-PAAc hydrogel and (b) gelatin-g-PAAc/MWCNT-COOH nanocomposite hydrogels

5.6 SEM images of (a) gelatin-g-PAAc hydrogel, (b) gelatin-g-PAAc/MWCNT-COOH nanocomposite hydrogels, (c) MWCNT-pristine and (d) MWCNT-COOH

5.7 TEM image of (a) acid functionalized multiwall carbon nanotubes and (b) nanocomposite hydrogel

5.8 Influence of pH of the medium on the swelling behaviours of the nanocomposite hydrogels: (a) pH = 4 and (b) pH = 7.4

5.9 Effect of MWCNT-COOH content on the swelling behavior of gelatin-g-PAAc hydrogel at: (a) 0 V and (b) 10V
5.10 Hemolysis results: (a) Hemolysis percentage of the nanocomposite hydrogel with 0.6 wt% (GA-6) and 0.1 wt% (GA-6) MWCNT-COOH content, (b) Photographs of RBCs treated with different samples (GA-6 and GA-1)

5.11 Drug release behavior of gelatin-g-PAAc/MWCNT-COOH nanocomposite hydrogel: (a) At different electric voltage applied: 0 V, 5 V and 10 V, (b) Drug release behavior as a function of applied voltage of 0V and 5V, altered at 30 min time intervals

5.12 Drug release behaviour of gelatin-g-PAAc/MWCNT-COOH nanocomposite hydrogel depending on the ionic strength of the release medium (0.1 M and 0.2 M NaCl solution)

5.13 Drug release behaviour of gelatin-g-PAAc/MWCNT-COOH nanocomposite hydrogel with various MWCNT-COOH content and at different electric voltages applied: (a) 0 V and (b) 10 V

5.14 3D response surface plot of drug release behaviour of gelatin-g-PAAc/MWCNT-COOH nanocomposite hydrogel: (a) showing the effect of amount of MWCNT-COOH (wt%) and time (hr) on release behaviour of vitamin B₁₂ and (b) showing the effect of applied voltage (V) and time (hr) on release behaviour of vitamin B₁₂