

## INDEX

- acoustic excitation, 15
- active flow control
  - acoustic excitation, 15
  - classification of, 3–4
  - jet, 16, 141–165
  - Lorentz force, 18, 246–264
  - oscillation and perturbation, 14–15
  - plasma actuator, 17–18, 206–241
  - synthetic jet, 16–17, 168–201
- AEROMEMS (Advanced Aerodynamic Flow Control using MEMS), 2
- AEROMEMS II, 2
- aircraft control effects
  - Gurney flap, 35–42
  - jet, 154–156
  - plasma actuator, 222
  - synthetic jet, 193–195
  - vortex generator, 61
- airfoil control effects
  - Gurney flap, 23–32, 42–46
  - jet, 147–150
  - Lorentz force, 255–261
  - plasma actuator, 214–215
  - synthetic jet, 190–193
  - vortex generator, 58–60
- AVERT (Aerodynamic Validation of Emission Reducing Technologies), 2
- biomimetic flow control
  - background of, 108–109
  - cactus-shape modification, 132–138
  - hairy coating
    - on bluff body, 110–111
    - straight wing, 112–114
  - leading-edge tubercles
    - delta wing, 120–125
    - flapping wing, 125–126
    - humpback whales, 115–117
    - noise reduction, 127
    - straight wing, 117–119
  - as passive flow control, 11–14
- riblet
  - characteristics of, 129–130
  - flow physics of, 129–132
- birds (as passive flow control), 11
- bleed (as passive flow control), 9
- bluff body
  - hairy coating, 110–111
  - Lorentz force, 261–263
  - plasma actuator, 222–228
- boundary layer control
  - acoustic excitation, 15
  - jets, 143–147
  - Lorentz force, 247–254
  - plasma actuator, 211–215
  - riblet, 129–132
  - roughness, 65–91
  - synthetic jet, 211–214
  - vortex generator, 50–52
- Breakthrough Vehicle Technologies Program (BVT), 2
- bump (as passive flow control), 5–6
- canard wing (controlled by Gurney flap), 40–42
- cavity, 6
- channel flow polymer effects, 100–103
- circular cylinder
  - cactus-shape modification, 132–138
  - hairy coating, 110–111
  - plasma actuator, 222–228
  - synthetic jet, 183–187
  - vortex generator, 55–57
- circulation control
  - jet, 158–161
  - plasma actuator, 236–238
- closed-loop control. *See also* feedback control
  - background of, 266–267
  - based on dominant frequency, 272–274
  - based on pressure variation, 268–272
  - based on reduced-order model, 267–268
  - based on spectrum amplitude, 274–275
- coherent structures polymer effects, 103–107

- continuous jet. *See* jet  
 cross-flow with jets, 143–147
- DBD plasma actuator, 17–18, 207–208, *See also*  
 plasma actuator
- delta wing control effects  
 Gurney flap, 35  
 jet, 151–154  
 leading-edge tubercles, 120–125  
 plasma actuator, 218–221
- dimensional analysis (synthetic jet), 170–171
- dolphin skin (as passive flow control), 13
- drag reduction  
 biomimetic flow control  
 cactus-shape, 132–138  
 hairy coating, 110–114  
 riblet, 129–132  
 Lorentz force, 249–254  
 plasma actuator, 222–228  
 polymer, 94–107  
 small disturbance, 7–9  
 splitter plate, 10  
 synthetic jet, 183–187  
 vortex generator, 55–61
- dynamic Gurney flap flow control, 42–46
- electromagnetic body force. *See* Lorentz force
- feedback control, 4, *See also* closed-loop control
- finite wing control. *See* straight wing control effects
- flapping wing with leading-edge tubercles, 125–126
- flow control classification  
 active flow control  
 acoustic excitation, 15–16  
 jet, 16  
 Lorentz force, 18  
 oscillation and perturbation, 14–15  
 synthetic jet, 16–17  
 plasma actuator, 17–18  
 characteristics of, 2–5  
 passive flow control  
 biomimetic, 11–14  
 bleed, 9  
 bump, 5–6  
 cavity, 6  
 Gurney flap, 5  
 polymers, 10–11  
 roughness, 7  
 small disturbance, 7–9  
 splitter plate, 10  
 vortex generator, 5
- flow separation control  
 closed-loop control, 272–274  
 hairy coating, 112–114  
 jet, 147–150  
 leading-edge tubercles, 115–129  
 Lorentz force, 257–261
- plasma actuator, 208, 214–215, 222–228,  
 238–240  
 synthetic jet, 187–193  
 vortex generator, 53–55
- forward-swept aircraft Gurney flap effects, 36–40
- friction drag effects  
 Lorentz force, 249–254  
 polymers, 100  
 roughness, 85–88  
 vortex generator, 61
- Gurney flap  
 airfoil control effects  
 configuration, 30–31  
 height, 23–28  
 lift enhancement mechanisms, 31–32  
 location, 28–29  
 mounting angle, 29–30  
 background of, 23  
 dynamic flow control, 42–46  
 jet, 163–165  
 as passive flow control, 5  
 plasma, 232–236  
 wing control effects  
 aircraft model, 35–42  
 delta, 35  
 finite, 32–33
- hairy coating, 110–114
- heat transfer  
 synthetic jet, 197–200  
 vortex generator, 61–62
- hump control effects by synthetic jet, 187–190
- humpback whales  
 leading-edge tubercles flow, 115–117  
 as passive flow control, 13
- inlet duct synthetic jet applications, 195–196
- insect wings (as passive flow control), 11
- jet.  
 as active flow control, 15  
 aircraft control effects, 154–156  
 airfoil control effects  
 dynamic flow control, 150–151  
 steady flow control, 147–150  
 background of, 141  
 delta wing control effects, 151–154  
 fundamental characteristics of, 141–147  
 novel concepts  
 circulation control, 158–161  
 Gurney flap, 163–165  
 vortex generator, 161–162
- leading-edge tubercles  
 delta wing control effects, 120–125  
 flapping wing control effects, 125–126

- leading-edge tubercles (cont.)
  - humpback whale flipper model control effects, 115–117
  - noise reduction in, 127
  - straight wing control effects, 117–119
- lift enhancement
  - biomimetic
    - hairy coating, 110–114
    - leading-edge tubercles, 115–129
  - closed-loop control, 268–275
  - Gurney flap, 23–46
  - jet, 147–165
  - Lorentz force, 255–261
  - plasma actuator, 214–224, 232–238
  - synthetic jet, 190–195
  - vortex generator, 58–61
- Lorentz force
  - as active flow control, 18
  - airfoil control effects, 255–261
  - background of, 246
  - bluff body applications, 261–263
  - boundary layer control, 247–254
- lotus leaf (as passive flow control), 14
- MEMS (micro-electro-mechanical system), 4
- multiple-control-surface tailless aircraft Gurney flap effects, 40
- NASA (National Aeronautics and Space Administration), 2, 61, 161
- National Research Council (NRC), 2
- noise reduction, 127
- open-loop control algorithm, 4
- oscillation (as active flow control), 14–15
- passive flow control
  - biomimetic, 11–14, 108–136
  - bleed, 9
  - bump, 6
  - cavity, 6
  - classification of, 3–4
  - Gurney flap, 5, 23–46
  - polymers, 10–11, 94–107
  - roughness, 7, 65–91
  - small disturbance, 7–9
  - splitter plate, 10
  - vortex generator, 5, 48–62
- perturbation (as active flow control), 14–15
- pipe flow polymer effects, 94–100
- pitching moment
  - Gurney flap, 28–29, 35–46
  - jet, 159, 164
- plasma actuator
  - applications
    - aircraft model, 222
    - airfoil, 214–215
    - bluff body, 222–228
    - boundary layer, 211–214
    - delta wing, 218–221
    - straight wing, 216–218
  - as active flow control, 17–18
  - background of, 206
  - classification of
    - DBD plasma actuator, 207–208
    - plasma spark-jet actuator, 209–211
    - surface corona discharge actuator, 208
  - novel plasma actuators
    - circulation control, 236–238
    - Gurney flap, 232–236
    - vortex generator, 238–240
- PLASMAERO (Useful Plasmas for Aerodynamic Control), 2
- polymers.
  - background of, 94
  - for channel flow
    - main parameters, 100
    - velocity statistics, 100–103
  - for coherent structures, 103–107
  - for pipe flow
    - main parameters, 94–95
    - velocity statistics, 95–100
  - as passive flow control, 10–11
- Reynolds number (synthetic jet), 173–175
- rod (passive flow control), 7–9
- roughness
  - background of, 65–69
  - as passive flow control, 7
  - in transitional flow
    - bypass effects, 80–85
    - delaying, 76–80
    - promoting, 73–76
    - vortical structure evolution, 69–72
  - in turbulent flow
    - effects on coherent structures, 89–91
    - friction drag effects, 85–88
- rump model (synthetic jet), 187–190
- saguaro cactus
  - flow control effects of, 132, 138
  - as passive flow control, 14
- sharkskin
  - as passive flow control, 13
  - riblet flow control effects, 129–132
- small disturbance (passive flow control), 7–9
- spanwise forcing (Lorentz force), 249–254
- sphere roughness effects, 7
- splitter plate (passive flow control), 10
- steady jet. *See* jet
- Stokes number (synthetic jet), 172
- straight wing control effects
  - biological techniques, 112–114, 117–119

- Gurney flap, 32–33
- plasma actuator, 216–218
- streamwise forcing (Lorentz force), 248–249
- stroke length (synthetic jet), 172–173
- surface corona discharge actuator, 208
- synthetic jet
  - applications
    - airfoil, 190–193
    - circular cylinder, 183–187
    - heat transfer, 197–200
    - hump and rump, 187–190
    - inlet duct, 195–196
    - vectoring angle, 196–197
    - vehicles, 193–195
  - as active flow control, 16–17
  - flow control principles of, 168–169
  - novel actuation, 178–179
  - numerical analysis, 179–183
  - parameter influence
    - dimensional analysis, 170–171
    - formation condition, 173–176
    - Reynolds number, 173–175
    - Stokes number, 172
    - stroke length, 172–173
  - velocity field characteristics, 176–177
- transition flow
  - plasma actuator
    - delaying, 211–214
  - roughness
    - bypass effects, 80–85
    - delaying, 76–80
    - promoting, 73–76
    - vortical structure evolution, 69–72
- trip wire (as passive flow control), 8
- turbulent flow
  - jets, 141–143
  - polymers, 94–107
  - riblet, 129–130
  - roughness, 85–91
- 21st Century Aircraft Technology Program (TCAT), 2
- Ultra Efficient Engine Technology Program (UEET), 2
- unmanned aerial vehicle (UAV), 193–195
- unmanned underwater vehicle (UUV), 193
- vectoring angle applications (synthetic jet), 196–197
- vehicle applications. *See* aircraft control effects
- Vehicle Systems Program, 2
- velocity field characteristics
  - jet, 141–143
  - plasma actuator, 206–211
  - synthetic jet, 176–177
- vortex generator
  - background of, 48–49
  - boundary layer control, 50–52
  - flow separation control, 53–55
  - fundamental flow characteristics, 49
  - heat transfer, 61–62
  - jet vortex generator, 161–162
  - lift enhancement and drag reduction
    - aircraft model, 61
    - airfoil, 58–60
    - circular cylinder, 55–57
  - as passive flow control, 5
  - plasma vortex generator, 238–240
- wing control effects
  - Gurney flap, 32–42
  - hairy coating, 112–114
  - jet, 151–154
  - leading-edge tubercles, 117–126
  - plasma actuator, 216–221
  - roughness, 79–80